THE ASCENT OF MOUNT
ST. ELIAS

THE ASCENT OF
MOUNT ST. ELIAS

[ALASKA]

BY H.R.H. PRINCE LUIGI AMEDEO
DI SAVOIA DUKE OF THE ABRUZZI
NARRATED BY FILIPPO DE FILIPPI
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THE AUTHOR'S
SUPERVISION

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VITTORIO SELLA AND
F. GONELLA

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Preface

IN the acute and subtle criticism of modern Alpinism with which Mr. Mummery concludes the narrative of his own expeditions, he says that "the true Alpinist is the man who attempts new ascents."[1] This opinion is undoubtedly shared by those climbers who turn eagerly to the few Alpine peaks forgotten or neglected by earlier explorers, and are conquering them in such rapid succession that soon no virgin summit will be left in that range.

But, in fact, the conquest of the Alps was virtually accomplished many years ago. The giant peaks were already won, and ambitious climbers, including several of those who had taken part in the great battle, then left home to seek new perils and fresh victories farther afield. Thus began a series of Alpine expeditions to remote and inhospitable regions, little known or totally unexplored—regions where technical experience of mountain work had to be supplemented by a wide and varied knowledge and power of resource in order to successfully cope with the obstacles and dangers of exploration.

Accordingly, the great mountain explorations of recent times

[1] *Vide* A. F. Mummery: *My Climbs in the Alps and Caucasus.* London: 1895. Page 327.

have been evolved from traditional mountaineering, and, more directly, from the conquest of the Alps. To this day the Alps remain the best teachers of the art. Theirs is the only school where it may be learnt and practised. The experience gained there has made it possible to establish in every detail a technique of climbing, and the comprehensive knowledge thus acquired of difficulties and dangers, and of the best means of overcoming them, has emboldened the Alpinist to attempt the conquest of the mightiest ranges of the world.

H.R.H. the Duke of the Abruzzi has joined the ranks of this small band of explorers, by making the expedition described in the present work.

The region dominated by Mount St. Elias offers such marked characteristics and unusual conditions of life and activity, that a thorough knowledge of these is required in order to grasp the real nature of the expedition. If the winning of St. Elias only meant the ascent of the terminal cone, made in one day from the Russell Col, it might be compared with many of the easier climbs in our own Alps. The reply given by one of our guides on his return exactly defines it:—"Just like the Breithorn, only much higher." Nor, strictly considered, would the altitude of the mountain (18,000 feet) render its ascent an exceptional undertaking, seeing that summits ranging to over 23,000 feet above the sea have already been conquered. But, when we take into account the entire route traversed by the expedition from the landing-place on the west coast of Yakutat Bay to the top of the peak, the true nature of the enterprise becomes apparent. The exceptional difficulty consists precisely in having to cross a zone of ice and snow of far greater extent than any to be found in other mountain groups. The Alaskan coast ranges are in the identical condition that prevailed in the Alps during the ice age; their glaciers descend to the sea, while their snow-line is as low as 2,500 feet above the sea level. Hence, the ascent of St. Elias differs fundamentally from any of the great climbs on record.

Mr. J. C. Russell, who was the chief explorer of the region traversed by H.R.H.'s caravan, has published some interesting remarks on the nature of the work.[1] He maintains that an approximate idea may be formed of the obstacles to be overcome in various ascents by comparing the height and distance of the summit beyond the farthest point where fuel can be found.

Now, since the limit of vegetation descends as we approach the poles, the proportionate difficulty of a given ascent might be calculated according to the latitude of the mountain, with due regard, of course, to its height. Considering some of the highest peaks of the American Continent from this point of view, Mr. Russell observes that on Chimborazo, in the Equatorial Andes, the last fire is lighted about 14,000 feet above the sea, and only 5,900 feet have to be climbed to reach the summit (19,500 feet). The great volcanoes of Mexico rise to an altitude of about 17,000 feet above the sea; while the limit of forest vegetation is over 13,000 feet. On Mount Whitney (14,000 feet), the highest peak of the Sierra Nevada, trees are found up to the level of nearly 11,000 feet. The snow zone in all these instances is about 5,000 feet in height, and can be climbed either in one day, or two or three at the most. Therefore, there is no need to carry up fuel, cooking-stoves, or specially prepared provisions; the requisite supply of blankets and warm clothes is greatly reduced, and the expedition can easily replenish its stores.

LIEUT. UMBERTO CAGNI, R.I.N.

In Alaska the conditions are entirely different. The snow-line,

[1] J. S. C. Russell: *Mountaineering in Alaska*. Bulletins of the American Geographical Society. Vol. XXVIII., No. 3, page 17; 1896.

instead of rising, as in the tropics, to 18,000 feet, drops, near Mount Logan and St. Elias, to less than 3,000 feet above the sea-level. Nearly 14,000 feet must be climbed above the snow-line to reach the summit; and it must be also remembered that those peaks are at a distance of 50 to 60 miles from the forest.

Thus the narrative of an expedition to Mount St. Elias has to chronicle whole weeks spent on vast glaciers, traversing more than 100 miles of ice and snow, conveying either on sledges or men's backs such heavy and complicated baggage as tents, blankets, fuel, provisions, oil and spirit stoves, clothing, and instruments. All this, too, in a region where bad weather is almost perpetual. On the lower glaciers the chilly rain seldom ceases, while, higher up, the heavy snowfall is so frequently renewed that it has no time to harden, and makes walking difficult and extremely laborious.

FRANCESCO GONELLA.

Owing to these exceptional conditions, I have considered it necessary to give full details of our preparations and equipment and have devoted a special appendix to it. I have also dealt minutely, and perhaps tediously, with the particulars of our daily life on the ice. This part of our journey was a monotonous march, without stirring or interesting episodes, through dense fogs and interminable snow-storms. We had hours, too, of intense enjoyment on the rare days of fine weather, when this strange region was revealed to our sight in all its vast grandeur. The whole was so utterly unlike the familiar scenery of our Alps, that I fear I shall have failed to give the reader even an approximate conception of what we beheld. Fortunately, Signor Sella's illustrations will indicate far better than my inadequate words the rich and diversified outlines of the scene, though even they cannot attempt to render the marvellous effects of light and colour.

His Royal Highness's expedition was exclusively Alpinistic. Its sole object was to reach the summit of Mount St. Elias, and all else was naturally subordinated to that aim. We were compelled to give up everything that might have hindered our march, while, to avoid increasing the already considerable weight of indispensable stores, all superfluities were left behind. The mountaineering season in Alaska lasts little more than two months. In September snow-storms continue almost without cease, and climbing becomes impossible. Our expedition took fifty-seven days from the coast to the summit and back again, without wasting one day or even one hour. Hence no topographical survey nor other scientific investigation could be made. Only an uninterrupted series of meteorological observations was taken. These are given in one of the appendices; while others contain details of the few zoological specimens collected on the snow surface of the Malaspina Glacier and of the minerals of the region.

VITTORIO SELLA.

H.R.H.'s expedition has proved the truth of a prediction made in 1887 by an Englishman, Lieut. H. W. Seton-Karr, R.N. This officer was one of the earliest explorers of the Mount St. Elias region, and in giving a report of his travels to the Royal Geographical Society, he stated that "if the mountain was to be ascended at all, it would only be accomplished by experienced Alpinists."[1] In the course of the ensuing discussion Mr. Freshfield

[1] Lieut. H. W. Seton-Karr: *The Alpine Regions of Alaska.* Proceedings of the Royal Geographical Society, May, 1887.

insisted that the art of climbing above the level of perpetual snow was as well established as that of navigation, and that no one inexperienced in it could any more successfully attack snow mountains than a landsman could navigate the sea.[1] In fact, there is a technique of mountaineering that has to be specially acquired.

No one who has seen guides at work on high mountains can doubt the truth of this dictum; but it is often denied by those who are ignorant of the subject. In many quarters it was a matter of great surprise that H.R.H. should take the trouble to export Italian guides to so distant a country, and it was asked of what possible use they could be among mountains unknown to them. Mr. Russell himself, who is not an Alpinist, although he has spent several months among the glaciers of Mount St. Elias, once stated that Alpine guides would be totally useless there;[2] and his fellow-explorer, Mr. M. B. Kerr, has repeated the assertion.[3]

In reality the same technique needed upon the glaciers of the Alps is equally adequate for other mountains, all being subject to the same physical laws, and sharing the same essential characteristics. Even upon Alpine glaciers there are no permanent tracks; in many instances a fresh route has to be found every year—and may be changed, perhaps, several times in a single season, owing to varied conditions. The best evidence in favour of guides is the remarkable exploring work that has been already accomplished with their help. Scarcely a single important mountain expedition in any part of the world has been performed without their skilled assistance. They were with Messrs. D. Freshfield, Craufurd Grove, M. de Décky, Clinton Dent, W. F. Donkin, A. F. Mummery, J. C. Cockin, V. and E. Sella, and many other Alpinists in the Caucasus; they were in the Equatorial Andes with E. Whymper, in the

[1] *Vide* also D. W. Freshfield: *The Exploration of the Caucasus.* London, 1896. Vol. I. p. 4.

[2] J. C. Russell: *An Expedition to Mount St. Elias, Alaska.* In the *National Geographic Magazine*, Vol. V., 3rd May, 1891, p. 166.

[3] M. B. Kerr: *Mount St. Elias and its Glaciers.* Scribner's Out-of-Door Library, "Mountain Climbing," p. 297 (New York, 1897).

Himalayas with W. W. Graham, W. M. Conway and others; with E. A. Fitzgerald in New Zealand and the Chilian Andes, and with W. M. Conway in Spitzbergen and Bolivia.

The idea occurred to H.R.H. of marking his appreciation of the guides' services on this Alaskan expedition by founding a permanent institution for their benefit.

The whole profit on the sale of the Italian edition of this work, together with all royalties and rights on foreign editions, will be dedicated to an Insurance Fund for Italian Guides. Their lives are exposed to continual hardship and risk, requiring great self-denial and the clearest sense of personal responsibility; while their families are in constant danger of losing their bread-winners by unforeseen accidents. They may now count in all such contingencies upon receiving prompt and effective help. Thus, thanks to H.R.H.'s Fund, the terrible consequences of Alpine disaster will be, in some measure, alleviated.

FILIPPO DE FILIPPI.

I am charged with the grateful task of offering the thanks of His Royal Highness and his expedition to all who promoted the success of the enterprise by their kind help and advice; and I trust I may be forgiven should I have inadvertently omitted any of their names from the following pages. A special debt of gratitude is due to Professor J. C. Russell for the permission to reproduce in this book his own sketch-map of the Mount St. Elias region.

I would also record our warm thanks to Professor C. Emery and his colleagues, Dr. G. Kiechbaumer and Professor P. Pavesi, and to Signor V. Novarese, who kindly examined our specimens and drew up the reports appended to the present volume.

PREFACE

When H.R.H. the Duke of the Abruzzi did me the honour of asking me to record the expedition, I was encouraged to undertake the task by the certainty of being able to depend upon the assistance of His Royal Highness and of my fellow-travellers. The narrative may be said to comprise the experiences of the whole party. My task has consisted in arranging and collating the diaries kept by H.R.H. and my colleagues, together with my own journal. These consist of notes and impressions scribbled at odd moments during the expedition, and it has been my aim to preserve as far as possible all the freshness and stamp of actuality infused into them by the circumstances under which they were written.

During the course of the work, H.R.H. and my companions have continually given me valuable advice and help, without which—my own mountaineering experience being less advanced —I should have lacked many of the elements required for the right understanding and interpretation of much that we had seen and done.

FILIPPO DE FILIPPI.

March, 1899

CONTENTS

LIST OF PHOTOGRAVURES

LIST OF ILLUSTRATIONS

PANORAMIC VIEWS AND MAPS

CHAPTER I

From Turin to Seattle

IT was the 17th May, and past 2 o'clock p.m. About a hundred persons were gathered on the platform of the Porta Nuova station alongside the French express—relatives, friends, and colleagues—all waiting to see us off and wish success to our long and difficult enterprise.

Then His Royal Highness, the Duke of the Abruzzi arrived, escorted by H.R.H. the Count of Turin. A few more affectionate farewells, and we were off. The Duke's party consisted of Lieut. Cavaliere Umberto Cagni, of the Royal Navy, officer-in-waiting to H.R.H.; Cavaliere Francesco Gonella, president of the Turin section of the Italian Alpine Club; Cavaliere Vittorio Sella, and myself.

It was a sultry afternoon of almost midsummer heat. We talked little, gazed dreamily at the panorama of green fields and the chain of the Alps shrouded by dark storm-clouds, and silently reviewed the last days of feverish bustle, and the active labour of preparation that had filled so many months. How the time had flown!

The delight and surprise with which we had received the Prince's first announcement of his plans, and the honour of being privileged to join the expedition, still tingled through us. Only six months before, H.R.H. was cruising round the world on the *Cristoforo Colombo.* But the long sea voyage had not made him forget the vast horizons he had seen, the war of the elements waged in the mountain world—the only other portion of Nature's realm that can rival the ocean in grandeur and force, in wild fury and peaceful calm. It was at Darjeeling, in Bengal, the 30th January, 1895, while gazing at the majestic peak of Kinchinjunga (28,000 feet above the sea), that an early ambition of the Prince took a definite shape. His voyage once accomplished, he determined to revisit India and attempt the ascent of some giant of the Himalaya range. Seven months later, Mr. A. F. Mummery, one of the most intrepid of contemporary Alpinists (who had ascended the Matterhorn with H.R.H. by the Zmutt ridge in 1894), lost his life while attempting to scale the peak of Nanga Parbat, 26,000 feet above the sea, on the borders of Kashmir and Chitral. Affectionate regret for his unfortunate friend, and a hope of subduing the fatal peak, moved H.R.H. to choose the same mountain for attack.

The *Cristoforo Colombo* anchored off Venice at the end of December, 1896, after a cruise of two years and two months, and H.R.H. immediately began to organize the expedition he had planned for the following summer.

Meanwhile, however, the plague had broken out on the west coast of India, followed by severe famine in the Punjab, the very region H.R.H.'s caravan must cross on the way to Kashmir. It was no longer a mere question of bad roads and mountaineering difficulties; we were faced by an obstacle no peaceful expedition could hope to surmount, *i.e.*, that of wild border tribes maddened by hunger. We anxiously followed the course of events, and it was soon clear that the Prince's Indian campaign must be deferred.

But H.R.H. was determined to undertake some serious expedition in the course of the summer, and, owing to the uncertainty of conditions in India, decided to make a complete change in his plans, and attempt Mount St. Elias in South Alaska, near the confines of the Arctic regions and bordering on the coast of the Pacific Ocean.

Situated at the northern end of an imposing range, the peak of St. Elias, 18,000 feet high, and visible from the sea at two hundred miles' distance, had attracted the notice of the first discoverers of the Alaskan coast a century and a half ago. But the mountain itself and its precincts remained unexplored until very recent times. The first attempt to reach its summit was only made in 1886, and was followed by three other expeditions during the next five years. All were equally abortive, but all reaped a rich harvest of information regarding the peculiar characteristics of a region where glacial phenomena are developed on a grander scale than in any other part of the world excepting the polar zone. The last attempt to conquer the peak had been made in 1891.

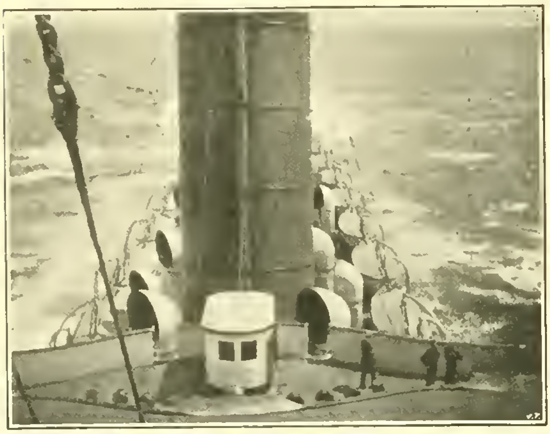
H.R.H.'s new plan was settled early in February, 1897, and the long and complicated preparations were immediately begun. It was necessary to make an accurate study of the equipment required for a campaign during which we should be completely isolated for two months, at least, and being far from any possible base of supplies, unable to repair any blunder or omission, which, even if apparently slight, might be enough to doom us to failure. We knew that we should have to camp out on the ice for several weeks in an extremely damp climate, where rain and snow often fall without ceasing for many days in succession and where nothing combustible could possibly be found. The whole of our camp material, our stores of clothing and food, had to be selected with a view to the conditions in which we should have to live.

Mr. Israel C. Russell, of Michigan (who had twice carefully explored the St. Elias region); Professor Fay, of Boston; Dr. Paolo De Vecchi, and Professor Davidson, of San Francisco, all gave us valuable assistance by supplying much practical information and many bibliographical details.

By the end of April everything was arranged. H.R.H. had chosen four Italian guides from the Val d'Aosta : Giuseppe Petigax and Lorenzo Croux, of Courmayeur; Antonio Maquignaz and Andrea Pellissier, of Valtournanche; and in addition to these, Erminio Botta, of Biella, who had been Sella's porter and photographic assistant in the Caucasus.

A few days before our start, we heard from America that Mr. Henry S. Bryant, of Philadelphia, was preparing an expedition for the same purpose as our own.

We left Turin with about sixty cases containing all the stores and equipment procured in Italy, our personal luggage, photographic appliances, and part of the camp and sanitary material.



CAPTAIN'S BRIDGE OF THE "LUCANIA."
From a Photo by H.R.H.)

Four days in London sufficed to get together all the other things ordered in advance, such as tents, ropes, waterproofs, etc. Our stock of food was to be laid in at San Francisco.[1]

We started for Liverpool at midday on the 22nd May. By 4 o'clock p.m. we were all on board the big Cunard liner *Lucania*, and half an hour later steamed away from the crowded pier and speedily lost sight of the line of white handkerchiefs waving us farewell. Behind the pier stretched the great gray mass of the city, bristling with chimneys and smoke stacks, under a thin veil of mist.

The voyage lasted six days, and with the usual monotony of a rapid crossing. There were few passengers, for spring is the moment for the American exodus to Europe, and the steamers

[1] *Vide* Appendix A for full details of our equipment.

perform their westward course half empty, until the autumn brings crowds homeward bound.

Our guides showed an indifference to their surroundings only to be compared with that of Arabs. Hurried away from their quiet valleys into the tumult of London, and thence on board, none of the strange new sights they saw roused them from their apathy. Of course they were sick during the first hours at sea, but speedily recovering, spent whole days in the second-class smoking-room playing endless games of cards.

On the 28th May, at 10.30 p.m., the *Lucania* anchored at the quarantine station outside the port of New York. Early next

ENTRANCE TO THE HARBOUR OF NEW YORK.

morning we steamed into harbour, and were instantly attacked by the first American reporters, who swarmed on board with the Health and Customs officers. Meanwhile the *Lucania* glided slowly up the great channel, through a crowd of steamers, tugs, barges, and sailing vessels; past the pleasant homes of Jersey, all bowered in greenery; past the gigantic elevators of New York harbour, and, after skirting the base of the colossal statue of Liberty, touched the Cunard pier at 8 o'clock. It was no light task to find, disentangle, and remove our sixty-six cases, struggling the while with a horde of porters, freight-agents, and fellow-travellers all busied as frantically as ourselves in recovering their luggage.

The same day, at 3 p.m., our guides started for San Francisco with part of the baggage. Professor Fay, of Boston, who had come to meet H.R.H., and kindly offered every assistance to our expedition, gave us the most efficient help. We learnt from him that Mr. Bryant had a fortnight's start of us in Alaska. We only spent one night in New York, and the next morning (30th May) were off to Chicago and San Francisco by the Pennsylvania Company's fast mail train.

The express whizzes through towns and villages at full speed, merely clanging a bell as a signal to clear the line. Day and night one hears this characteristic warning in traversing inhabited places or entering stations. At first the country is flat, scantily wooded,

NEW YORK, FROM THE HARBOUR.

and chiefly arable land, but it soon becomes hilly, with many pleasant homesteads surrounded by trees, and before long we are in a mountainous district, with wide valleys and forest-clad slopes.

Passing unawares from one State to another, we reached Chicago early in the morning of the 31st. Here a few hours' halt gave us time to visit the famous "Stock Yards," and to view the great military parade celebrating the anniversary of the War of Secession. Leaving in the evening, we awoke next day in the smiling Omaha region on the banks of the Missouri, which flows majestically between rich meadows and groves enlivened by numerous herds and flocks. Soon the train begins to climb the first foothills of the "Rockies," the grass becomes thinner, then disappears, and is replaced by an undulating waste of yellowish sand, dotted with patches of low, prickly scrub. The train mounts, at an easy gradient, to a series of terraces, whose precipitous cliffs overhanging the plain are furrowed with rain-channels. Here and there on the vast yellow plain below one sees patches of grass near wells, with a few browsing cattle and herdsmen's huts. The scanty villages scattered over the waste consist of miserable wooden shanties, hastily run up for the use of nomad cow-boys, condemned to be perpetually on the move to fresh pastures.

Towards evening, we see the first buttresses of the Rockies, and one or two snow-peaks cutting the line of the horizon.

Just for a few hours then and the next morning we felt chilly, and a little sleet was falling on the summit of the pass, at 8,240 feet above the sea.

CROSSING THE SIERRA NEVADA.

But the other side of the range we are again in the heat. We skirt the northern shore of the Salt Lake, across an arid, grassless waste, so uniform in tint that one cannot distinguish the limit between sand and water. The lake is a desert expanse ; the Wahsatch hills shrink to nothingness at the feet of the precipitous Rockies. The day is dull and dreary ; but towards evening, when the waste is flooded with a rosy glow, and shadowy blue peaks are piled against the horizon, the landscape is full of poetic charm. After thirty-six hours in this desert, there comes a sudden change of scene. The line begins to re-ascend, and soon climbs the picturesque chain of the Sierra Nevada. Here and there the snow stretches down to the railway, which now climbs to 7,200 feet above the sea. Broad valleys and ridges are clothed with dense forests of pine. Unfortunately, the snow-sheds protecting the road from avalanches too often cut us off from the view. A few dazzling streaks of sunshine pierce through cracks in the timbers, and then the volume of smoke in the surrounding gloom is studded with sparkles of light.

On the Pacific side the descent is very steep, and the line sometimes makes abrupt turns at the edge of precipices above unknown depths. Gold-mining camps have cleared great strips of forest and left hollows of yellow, sedimentary soil. Still hastening downwards, we traverse the fertile Sacramento valley, a paradise of

TRAIN ON FERRY-BOAT.

(*From a Photo by H.R.H.*)

fruit trees, olives and vines, with a sea of ripening oats waving in the wind. At Port Costa the whole train is ferried across the arm of the sea that runs up to California by the Golden Gate. Another hour's travel brings us to Oakland, where a steamer takes us across the bay to San Francisco. It was now 9 p.m., 3rd June, and the great amphitheatre of the city glittered with innumerable lamps, accentuating the geometrical lines of the streets.

Here in San Francisco more preparations filled our time. It was necessary to order in supplies of food. During the railway journey, H.R.H. had made his plans, and arranged every detail with us. Soon our rooms were filled with samples of biscuits, tinned meats, preserved soups and vegetables, condensed milk, chocolate, etc., etc. With the restricted commissariat before us, everything had to be tasted, in order to choose what would be least likely to pall. Then, our purchases completed, H.R.H. worked with us a whole day and late into the night, making up fifty rations, each ration containing one day's supply of everything required to provision ten persons, *i.e.*, ourselves and the guides.

THE VALLEY OF SACRAMENTO, CALIFORNIA.

Next, these fifty rations were packed in as many tin cases, hermetically closed; and fifty small bags were filled with tinned provisions requiring no extra protection from damp. By midnight, June 8th, we brought our work to an end. Everything was in order, and the whole equipment now weighed about 2,700 pounds.

San Francisco is a charming city, with clean, spacious streets full of light and air. It has fewer oppressively enormous buildings than Chicago or New York. Being an agricultural centre, it is very quiet and exempt from the feverish turmoil of the industrial Eastern States. The higher parts of the city, commanding views of the ocean and the beautiful bay, contain hundreds of villas and cottages, nearly all built of wood. And, as this material readily lends itself to decorative freaks, fancy has run riot in the queerest carvings and adornments of every shape and size. Here too, as in Chicago, the foreigner is surprised by the total absence of carriages.

Nowadays in America the horse has become almost exclusively

THE SHASTA VOLCANO.

an article of luxury, since for practical purposes, electric or other mechanical traction covers the ground quicker and at far less cost.

In San Francisco Mr. M. B. Kerr, who had acted as topographer to the first Russell expedition to St. Elias, presented H.R.H. with an outline map of the region, together with much interesting information regarding its glaciers.

Dr. P. De Vecchi, Professor Davidson, Mr. MacAllister, secretary to the Geographical Society, and the secretary of the Alaskan Commercial Company, all did their utmost to assist our expedition.

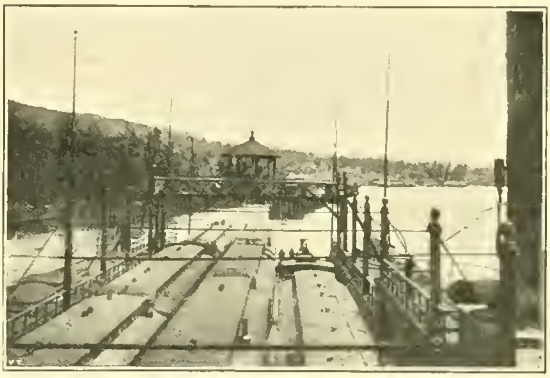
By arrangement with the Alaskan Commercial Company, one of their steamers altered its course in order to afford us a quick passage across the Pacific from Sitka to Yakutat, where there is no regular line of navigation.

The further we went, the more impatient we felt to reach the field of action, and gladly resumed our journey on the evening of the 9th June. Our route followed the long Sacramento valley between the Coast Range and Sierra Nevada, sometimes in the depths of narrow gullies, sometimes on the crest of some mountain spur.

A CALIFORNIAN RAILWAY STATION.

Dense masses of pine, fir, and cedar cover all the ridges about us : chain beyond chain, a perfect tangle of mountains ! We pass mineral springs with spouting geysers twenty to thirty feet high, and at the head of the valley come in sight of the volcanic Mount Shasta, a smooth, snow-clad cone rising to an altitude of 14,350 feet, the boundary between the Sierra Nevada and the Cascade Range. Shasta Vale is a spacious, treeless pasture-land at about 2,500 to 2,600 feet above the sea ; but as soon as we enter the State of Oregon the woods close round us again in all the wild luxuriance of a virgin forest. There are coniferæ of every size and variety, oaks, masses of thick-leaved plants, innumerable varieties of foliage in every shade of green. The railway rapidly climbs the mountain in the boldest curves, and as we rush along giddy crests we look straight down into deep ravines furrowed by the line we have travelled.

In the moonlight the forest becomes fantastic. Our track is hedged in between dense walls of greenery; the night breeze is charged with resinous odours and whiffs of strange fragrance from unfamiliar shrubs. At every turn, our train seems to be cleaving its own road through the wilderness. As the engines are fed with wood, the funnels send out spears of flame and showers of sparks, flashing light for a moment on the nearer trunks. Here and there wide glades open before us, bristling with the skeletons of charred trees, victims of forest fires, stretching their mutilated, blackened limbs in the moonlight. A camp-fire here and there by some lonely hut only increases the sinister gloom of the woods behind it. Whenever the train has to cross a gully spanned by one of those slender bridges on wooden stilts, that even by daylight seem so insecure, it appears to be flying through space unsupported.



FERRY-BOAT ON COLUMBIA RIVER.

On the morning of the 11th June we entered Washington State, crossing the huge Columbia River on a ferry-boat. The busy stream, crowded with steamers and serpent-like rafts, runs between low wooded hills. Being just now in flood, it spread over the valley to the edge of the railway bank. Passing through the forest that runs down to the coast, we reached Seattle at 6 o'clock p.m.

This town, at the head of Elliot Bay, the inlet of one of the numerous intricate channels twisting southwards from Vancouver into Puget Sound, is hardly more than the skeleton of a great city. It was laid out in 1889 after the greater part of the old settlement had been destroyed by fire, and was expected to outdo San Francisco in size and prosperity. So far, the prediction has not been fulfilled. Stately mansions are flanked

SEATTLE, FROM THE SEA.

by wretched hovels, and vacant building plots leave ugly blanks in the spacious streets.

Five days before our arrival, the yacht *Aggie*, chartered by the Prince, had sailed from Seattle harbour with ten American porters on board. These were picked men engaged for the expedition and under the command of a Mr. Ingraham, who had been recommended to H.R.H. by Professors Russell and Fay. Ingraham had taken charge of the camp material and of two months' supplies for himself and the men. The *Aggie* was to wait for us at Sitka.

After forty hours in Seattle, the morning of June 13th found us on board the small steamboat *City of Topeka*, bound for Sitka, the capital of Alaska.

CHAPTER II

From Seattle to Juneau—The Alexander Archipelago and Alaska[1]

THE word "Alaska" occurs for the first time in the chart of Captain Cook's first voyage (1778). It is derived from the aboriginal word "Al-ak-shak," signifying "the great continent," and the country was discovered by Vitus Behring in 1741. Soon afterwards its shores were widely explored by numerous expeditions, both Russian and Spanish; the latter moved by the hope of discovering the famous North-west Passage, the former by greed of conquest. Remaining subject to Russia down to 1867, Alaska was then sold to the United States for seven million dollars. It covers an area six and a half times larger than Great Britain (577,390 square miles), with a coast line of 26,000 miles. It runs westward into a peninsula, which, together with the chain of the Aleutian Isles, divides the Behring Sea from the Pacific; southward it is prolonged into a narrow tongue of land skirting British Columbia for 300 miles.

The Aleutian Islands are famed for fur-seals of the highest market value, which abound there. Accordingly the American Government has found it necessary to do as the Russians did and

[1] *Vide* Appendix F for index of the authorities referred to for particulars in this and the following chapter.

regulate the seal fisheries by very stringent laws and international conventions for the due preservation at the north-western extremity of the American continent of the precious amphibiæ, which have been almost exterminated elsewhere.

Off the west coast of Alaska there are great "banks" yielding cod and salmon, and immense shoals of herring. The region also carries on a flourishing fur trade with the Indians of the interior. The mineral wealth of Alaska is very great. Deposits of gold, silver, platinum, iron, and coal promise future prosperity to the land.

According to the census of 1890, this vast region then contained barely 32,052 inhabitants, composed of 4,298 whites, 23,531 Indians, and 4,223 Mongols and half-breeds.

The Indians are divided into four leading tribes, with different languages and customs; and although no indication of their origin is found in their myths and traditions, experts now maintain that their ethnographical characteristics prove them to be descended from the aborigines of the central parts of the continent.

The four principal groups, subdivided into many lesser tribes, are the Eskimo or Innuit, inhabiting the coasts of Behring Sea and the Polar Ocean; the Aleuti, of the Alaskan peninsula and Aleutian Isles; the Athabaskan or Tinneh, of the interior; and the Thlinket or Tlingit, whose villages lie on the southern coast of Alaska and in the islands of the Alexander Archipelago. These last are 4,500 in number, and, owing to prolonged intercourse with white men, have changed their customs more than the others. For a stretch of 600 (geographical) miles, from Cape Flattery to Cape Spencer, along British Columbia and the southern arm of Alaska, the western shores of North America are fringed with innumerable islands of all sizes, from Vancouver Island, 250 miles in length, to small rocks barely emerging from the surface of quiet channels. Mount Olympus to the south and Mount La Pérouse to the north respectively dominate the Straits of Juan de Fuca and Cross Sound, the two outer gates of the archipelago. Both to north and south, channels running inland beyond the limits marked by the two mountains, form Puget Sound in Washington State, and Lynn Canal and Glacier Bay in Alaska. The part of the archipelago (little more than one-third) belonging to Alaska is known as the Alexander Archipelago.

The political frontier of Alaska, starting from the southern end of Prince of Wales Island, passes through the centre of Portland Channel to the 56° parallel, and then follows the crest of the mountain chain on a line with the coast, wherever the chain is within $34\frac{1}{2}$ miles from the sea, as far as the 141° meridian. At the point, however, where the Coast Range intersects the 141° meridian (Greenwich), this meridian marks the frontier as far north as the Polar Sea. The right angle thus formed, where the frontier, ceasing to run along the coast line, turns abruptly and follows the 141° meridian, is occupied by no less colossal landmark than Mount St. Elias.

The greater part of the interior of Alaska is entirely unexplored. The rainfall is scanty, and the climate arctic. The ground at a foot beneath the surface remains frozen throughout the year. During the seven months of winter, daylight only lasts four hours, and the temperature drops to 59° F. below zero.

There are no transition seasons, and the fine summer months are comparatively warm (60°-70° F), with the sun above the horizon for twenty hours daily. Towards the Polar Ocean and Behring Straits there are vast "tundras,"[1] as in Northern Siberia, the rest of the soil being boggy, with scattered brushwood or patches of dwarf trees near the rivers. The mountains only reach an altitude of 4,000 to 5,000 feet, and have no glaciers. The whole country is intersected by a close network of rivers and lakes, connected by so many branches that it is declared possible to traverse Alaska almost entirely by boat from one to the other sea. One giant river, the Yukon, bigger than the Mississippi itself, rises in Canada, runs 2,000 miles through Alaska, and falls into the Behring Sea.

[1] "Tundras" are the vast treeless plains of the Arctic region, carpeted with moss and lichen.

The climatic and geographical peculiarities of the coast zone of Southern Alaska are completely opposed to those of the interior. The great mountain ranges are clad with dense forest growth, and the warm current, Kuro-Siwo, from Japanese waters, makes the climate very mild. Near the coast the mean temperature of the sea is 50° F. Winter begins in December, and in May the snow vanishes from the lowlands. At Sitka the medium winter temperature is 32·5° F., and there is a variation of barely 25° F. between the summer medium and the winter. The atmosphere is nearly always surcharged with moisture, and the hot south winds, laden with

IN PUGET SOUND.

watery mists, breaking against the lofty coast ranges, cause tremendous falls of rain and snow. At Sitka the average yearly rainfall is about 100 inches, and throughout the region there are not more than seventy really fine days in the year. This accounts for the huge size of the glaciers along the coast, some of which positively pour into the sea.

Only the south coast, and, to be precise, only the portion covered by the Alexander Archipelago, possesses regular maritime communication with the United States. The service is carried on by two postal steamers, the *Queen* and the *City of Topeka*, which thread the intricate island channels by the so-called "Inland Passage," between Seattle (or Tacoma) and Sitka.

We embarked early on the morning of the 13th of June on the smaller boat, *City of Topeka*, which after the *Lucania* seemed the reverse of sumptuous. But the grand scenery of the voyage was ample compensation for lack of comfort. The boat had to put back to Tacoma to complete her lading, so that the whole of our first day was spent in Puget Sound. Here the shores, vandyked in countless bays, are mossed with green pine to the water's edge, while towering in the background, the distant snow-peaks of the Cascade

SUNSET IN PUGET SOUND.

Range cluster round their monarch, Mount Rainier (14,400 feet high).

We had about seventy fellow-passengers, mostly business men, a few young ladies returning home to Alaska from schools in California or Washington State, and a sprinkling of tourists. In the second class, with our guides, were some miners, bound for the up-country gold diggings.

The stores of poultry, fruit, and vegetables on deck, together with the cargo of meat and other provisions below, gave a poor idea of the food resources of Alaska. In fact, the summer there is too short for the growth of cereals, which can only ripen in certain spots, and even potatoes are not raised every year. Vegetables have been cultivated here and there with some success lately, thanks to infinite pains and patience. Cattle-breeding has great difficulties to contend with, as the animals suffer seriously from their prolonged winter confinement. The reindeer, introduced a few years ago, seem to be the only beasts that really thrive in Alaska.

By the afternoon we were off Seattle, and late in the evening

QUEEN CHARLOTTE SOUND.

were near the mouth of Admiralty Inlet, in the Juan de Fuca Straits, and steering for Victoria, the capital of Columbia, on Vancouver Island.

Once through the Juan de Fuca Straits, we were in Columbian waters, between Vancouver and the mainland, first in the wide Gulf of Georgia, amid an amphitheatre of peaks, for the most part still covered with snow, and then through the tortuous channels of Discovery and Johnstone Pass, enclosed by high cliffs, against which the water breaks in seething floods, and where the course seems barred at every turn by precipitous walls of rock.

AN EVENING IN ALASKAN WA[illegible]

Emerging into Queen Charlotte Sound, the steamer threads her way through a labyrinth of islets and reefs barely projecting above the surface, at some distance from the low shores.

After rounding the northern end of Vancouver, the boundless ocean opens out, and our small vessel pitches heavily among the rollers; but soon we enter another smooth channel overshadowed by great cliffs.

The entire coast, with all its islands, rocks, gentle slopes,

IN THE CHANNELS OF THE ARCHIPELAGO.

sheer cliffs, and dark gorges, is so overgrown by dense forests of firs, that, from a distance, the whole seems one mass of velvety green.

The prevailing growth throughout the forests of the archipelago is the Sitka fir (*Abies sitkensis*). This tree supplies the natives with building materials, household utensils, canoes and sledges, while its branches serve for torches during the long winter nights. Less numerous are the white larch, the pine (*Pinus con-*

torta), and certain varieties of fir. The yellow cedar (*Cupressus nutcanensis*), a much-prized wood, was nearly exterminated under the Russian rule.

The forests are populated by deer, roebucks, bears (both brown and black), wolves, foxes, sheep, and mountain goats. Stags are occasionally caught while swimming some channel to escape the wolves.

Now and then an Indian fishing village on the margin of the forest, the light canoes, or some tiny boat with a triangular sail,

IN THE ALEXANDER ARCHIPELAGO.

plying close to the shore, lend a wild charm of remoteness to the scene.

As we go farther north the days grow longer, the air is more misty, especially in the morning and early afternoon; the cold, diffused light spreads a general monotony, and the leaden sky is reflected in a colourless sea.

Entering Alaskan waters, the steamer touches Mary Island, a small outpost of the Alexander Archipelago, and after calling at a few Indian villages to land stores we reach Fort Wrangel, on the island of that name, and the first Alaskan town of any importance. Importance, however, is a relative term. The town-ship counts a few hundred inhabitants, chiefly Thlinket Indians, whose huts are ranged along the beach near the better sort of two-storied dwellings of the whites.

MARY ISLAND.

The little town is commanded by a Government House, where the authorities reside. Behind the Indian cabins are the tombs of certain *schamán*, or wizards, guarded by masts, some 80 to 100 feet high, bearing roughly carved symbols, in the shape of animals, on their summits. In front of some of the houses, similar poles are erected. These are *totems*, or ancestral pillars, the equivalents of family crests among the Indians. Before a man's house, on his canoe, or his garments one finds the *totem* of the tribe or family to which he belongs, and it is even worked into personal ornaments of carved horn or ivory, sometimes showing a certain artistic sense.

The Thlinket are schamánists or fetichists ; they believe all natural phenomena to contain spirits, good or evil. The mightiest of these spirits is Yehl, symbolized by the raven ; next Kanukh, by the wolf ; and Tset'kh, by the whale. Many of the Thlinket are now converts to Christianity, although it is hard to decide whether their comprehension penetrates beyond external rites to a genuine religious conception. Many of them are clothed like white men, some can speak English, and a few have learnt to read and

WRANGEL STRAITS.

write. But outwardly, at least, they show few signs of civilization. They are less ferocious than a century ago, and have almost given up the practice of tattooing and of wearing rings in the lips or nose; but their appearance and mode of life are pretty much the same as were described by Vancouver in 1794. They are revoltingly dirty; inside and out their dwellings are intolerable, owing to the stench of accumulated filth.

TOTEM POLES AT FORT WRANGEL.

On the mainland, near Fort Wrangel, is the mouth of the Stikine, the chief river of Southern Alaska.

Springing from glacier torrents, its milky current makes a distinct white streak in the blue ocean to a considerable distance out at sea. Both in 1862 and 1875, the discovery of auriferous deposits in the upper river basin awakened great hopes for the future of Fort Wrangel, but the "placers" yielded so little ore that they were soon abandoned.

Fort Wrangel is the gate of the northern seas, and beyond it we are soon in the midst of truly Arctic scenery. The passage of

Wrangel Straits is difficult navigation during the first few hours, owing to the numerous reefs just above the surface and the force of the tidal currents; but the channels widen later on. Outlines of snow mountains and of rocky peaks are faintly distinguished, apparently at a great distance, and the greenish-white *séracs* of the first glaciers are visible below the sullen, grey mists. Next we enter Prince Frederick Sound, resembling a vast, clear, placid lake. Far away great snowy ranges rise above the water, and the sea is dotted

JUNEAU.

with numerous rocks and islands. Suddenly the first iceberg is signalled, and soon our steamer is in the midst of white floating masses, which drift slowly and noiselessly with the current, rocked by the long waves in the vessel's wake. Beneath a sky heavy with purple clouds, projecting vast shadows on the face of the water, the pure white icebergs seem to radiate a brilliancy of their own in the cold, diffused light of the colourless atmosphere around them.

Dark green fir-clad islets emerge in the midst of this polar scene, and all about us is an indescribable stir of life, a crying and calling of birds, a coming and going of living things. Bald-headed eagles perch motionless on the firs, flights of gulls circle round the ship; the very icebergs afford a resting-place to the flights of wild duck which fringe every ledge and take wing in clouds at the approach of the steamer. The glistening back of a whale suddenly emerges from the smooth green sea, only to disappear again in a swirl of spray. Schools of porpoises disport themselves in the

JUNEAU BAY.

wake of our vessel as she glides through masses of jelly-fish and great waving weeds.

The next port we touch at is Juneau, founded in 1880 by a prospector who was tempted to settle there with a few comrades on the strength of certain nuggets picked up by Indians near the spot. Although the youngest-born of Alaskan towns, Juneau has quickly become the most populous. In 1890 it already counted 1,253 inhabitants, and is rapidly increasing. As usual, the houses are of wood and the streets paved with planks, save in the higher part of the city, still in course of construction, where tree-stumps as yet fill the gaps among the houses. Juneau has electric light, public baths, hotels, theatres, three churches—Catholic, Greek, and Protestant—one hospital, and a local newspaper. Its prosperity is derived from the neighbouring gold-mines at Treadwell, and from being the starting-point and

A STREET IN JUNEAU.

base of supplies for diggers bound inland to the Yukon basin. Small gold-camps are scattered all over Alaska, and prospectors have been exploring the country in every direction for a good many years. Since 1885, however, the chief mining centre is the Upper Yukon basin, where gold-washing and digging have been gradually extended to all the tributaries of the main river. It was in one of these lateral valleys, the Klondike, that the fabulous gold deposits which have startled the world were first discovered a month after our arrival. In 1890, the yield in this district was 50,000 dollars; in 1891, 70,000; and in 1896 the population had risen to 1,700 souls, and the yield to 1,400,000 dollars.

JUNEAU, FROM THE SEA.

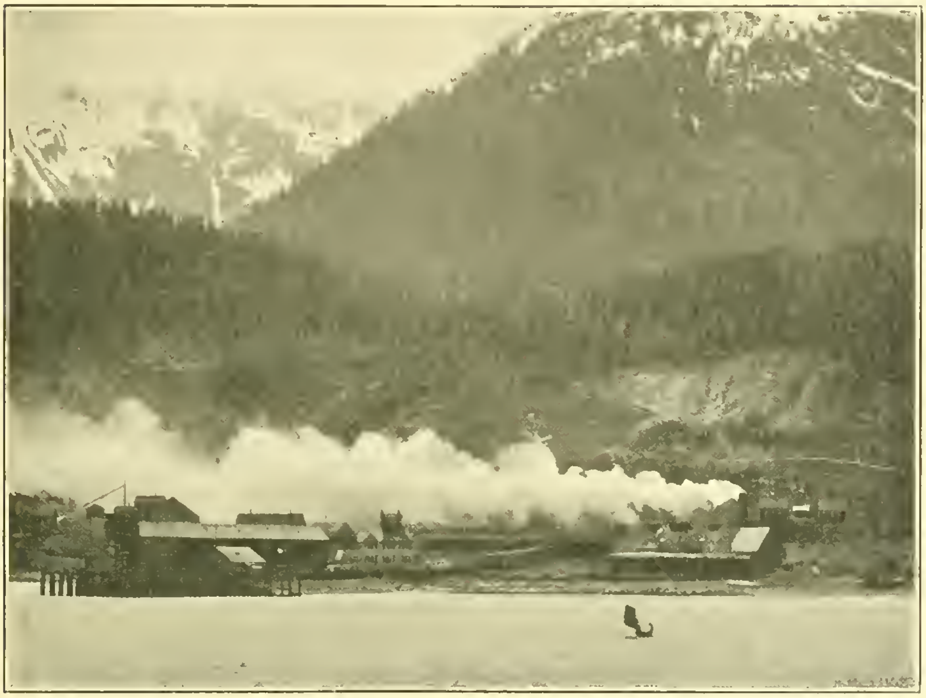
The district which promises the largest yield covers an area of 700 square miles. The miners, chiefly Americans, have founded a settlement known as Dawson City, which is situated in British territory, being to the south of 141° meridian, as is indeed the greater portion of the gold-bearing district. This town is nearly 676 miles from Juneau. The two routes most frequented are by the passes of Chilkoot and Chilkaat, *cols* of the Coast Range, at the extremity of Lynn Canal, north of Juneau. By these passes the route descends either to the White River or to the Lewis, both tributaries of the Yukon, and the journey is continued on boats and rafts. Dawson City can be also reached by going up the Yukon from its mouth in Behring Sea, but this is a much longer route.

A CHURCH IN JUNEAU.

The severe climate of the interior, the distance of Dawson City from the coast, and the enormous difficulties of transport, render the victualling of the numerous immigrants a very difficult problem.

[illegible] ACIER BAY

Besides, gold-washing can only be carried on for about three months of the year, as the intense cold of the long, dark Arctic winter makes all work impossible.



THE TREADWELL GOLD-MINES.

CHAPTER III

From Juneau to Yakutat—The Muir Glacier, Sitka, and the Coast Range

THE night after leaving Juneau was the most fantastic of the voyage. As the sun went down, the whole horizon, bounded by vast snowy ranges, became marvellously clear, and was gradually tinged with most delicate sunset hues. At 10 p.m. it was still broad day; then, until midnight, the light waned little by little. The rosy glow on snowfields and summits became paler; the orange, blue, and carmine streaks on the sea gradually melted into fainter and more exquisite tints. But, in the west, a band of tawny crimson still hung, throwing strange reflections on the mountains beneath. The rest of the sky was a pale blue, growing fainter and colder towards the horizon. Against this, all the mountains stood out in their minutest details, with the crude white of their snowfields and the curious, delicate indentation of their crests. No light proceeded from the dull, yellow moon; the stars were few and faint. At 1.30 a.m. the new day began to dawn, while the colours gradually faded away from the west. Our vessel glided on silently—furtively, as it were—in the solemn stillness of this enchanted world.

After rounding the headland dividing the Lynn Canal from Glacier Bay, we began to meet icebergs, few and scattered at first, but soon many in number—fragments of the glaciers that fall into the bay a little way ahead. But we were in the realm of marvels, of sudden changes of scene. The air being saturated with moisture speedily condenses at the least lowering of temperature, whenever the wind veers or the sun goes behind a cloud. A sheet of gray fog lies low on the horizon, gradually spreading

AN ICEBERG IN GLACIER BAY.

until the whole sea is shrouded by a thin white veil, that is luminous, but not transparent. Then our engines have to be stopped, to avoid collisions with icebergs. The latter are not alarming in appearance; but as the mass of ice seen above the water is but a small fraction of the total bulk, the shock of collision might be serious. They emerge suddenly out of the fog, and, drifting with the current, vanish as suddenly as they come.

All at once the sun reappeared: a pale disc in a huge halo of vapour, and in a few seconds, as by magic, the fog cleared, and light and colour returned. The gray sea changed to amethystine blue; thousands of wild duck, startled by the proximity of the steamer, rose in long, clamorous flights from icebergs and water.

But in ten minutes we were once more wrapped in fog. And for hours these changes of scene went on, only varied by the amusement of seeing fragments of the bergs fished up to replenish our stock of ice.

GLACIER BAY.

At last the sun, risen high above the horizon, finally disperses the fog, so that our vessel is able to make the bay at the foot of the majestic Muir Glacier. Now the whole atmosphere is brilliantly bright and clear. The blue surface of the sea, scarcely a shade deeper than the sky, is slightly ruffled and intersected with streaks of shining water traced by the currents, and dotted with innumerable small icebergs, while here and there some gigantic block preserves still the irregularly geometrical form peculiar to *séracs*.[1] Some

[1] Mr. Wright, the geologist, measured some icebergs in Glacier Bay, of 500 feet in length and with a bulk of 40,000,000 cubic feet.

stand high out of water, others form huge floating slabs; now and again, a combination of many smaller bergs welded together assumes a quaint and unusual shape.

Among the white blocks with their delicate, flower-like frost-work, we note a few polished masses of sea-green hue. These are bergs which have turned upside down, thus exposing the portion originally submerged.

This bay is bounded by two large glacier beds. To the

AN ICEBERG IN GLACIER BAY.

left rises the range dominated by mounts La Pérouse, Crillon, and Fairweather, which rival the grandest of known peaks in the boldness of their outline; the nearer peaks, lower and less isolated, remain almost unnoticed before these majestic summits. The whole chain covers a promontory of from thirty to forty miles in width, between Glacier Bay and the Pacific Ocean. Four glaciers flow down into the bay, divided from the Muir Glacier by a small rocky spur that shoots out into the sea and splits the gulf in two.

To the right of the Fairweather chain, and at the head of the inlet, the Muir Glacier forms an enormous plateau, ending abruptly at the water's edge in a sheer wall of ice, one mile in length and 250 feet high, crowned by countless pinnacles and spires. Its base is undermined by the force of the waves, and worn into numerous gullies and caverns. Every few minutes there is a cannonade of ice-blocks falling from this cliff, which, as they strike the water, throw up clouds of spray into the air. From this vast front of ice, broken and seamed as it is by innumerable *crevasses*, the glacier stretches inland almost level, to a huge amphitheatre fifty or sixty miles in diameter, where it is fed by nine greater and seventeen lesser ice-streams flowing down from summits which have no special beauty of outline.

GLACIAL TORRENT IN THE MUIR MORAINE.

The Muir Glacier was first explored in 1879 by the geologist whose name it bears; in 1886, Mr. H. F. Wright, with two companions, spent a month in the bay to study its rate of motion. His observations have established some surprising facts regarding the motion of the glacier.

During the month of August, an average of 40 feet flows into the bay, *i.e.*, 70 feet in the centre and 10 feet at the sides.[1] As the front of the Muir Glacier has a section-surface

[1] The rate of descent in glaciers is determined by the same laws as that of rivers. In either case the current is swifter in the centre than at the sides, swifter also nearer the surface than deeper beneath.

of 5,000,000 square feet, it discharges daily into the sea more than 200,000,000 cubic feet of ice. Only in Greenland has anything approaching this velocity been noted. The glaciers of the Alps move at a much slower rate; the maximum speed, as shown by the repeated observations of Hugi, Agassiz, Forbes, and Tyndall, being, in the case of the Aletsch Glacier, 19 inches, of the Grindelwald, 22 inches, and of the Chamonix Mer de Glace, 30 inches daily.

This notable difference seems all the more remarkable, as the Muir Glacier comes down at a gradient of barely 100 feet to the mile, whereas the easiest gradients of Alpine glaciers are of about 250 feet to the mile. Accordingly, another explanation is required to account for the difference; and considering the Muir Glacier's enormous superiority in bulk over those of the Alps, we are forced to conclude that a glacier's rate of movement depends far less on the inclination of the bed than on the volume of the ice-current itself (see Wright).

"CITY OF TOPEKA" STEAMBOAT IN GLACIER BAY.

There are many infallible signs that the Muir Glacier is shrinking, and at so rapid a rate, that its cliff-lip has receded more than a thousand yards between the years 1886 and 1890.[1] Going back to

[1] Readers unacquainted with glacial phenomena may find a discrepancy between our statement that the front of the Muir Glacier has shrunk back, and the rapid movement in advance verified by Wright. Yet this discrepancy is only apparent. The bulk of a glacier is owed to two causes, which act in a contrary way: the quantity of fallen snow, and the melting of the ice by solar heat. The first cause always over-rules the second in the upper portion of the glacier, inasmuch as the yearly snowfall there is greater than the amount melted by the sun, and it is precisely the overplus that drops

earlier times, we have a valuable document dating from 1794, in the description of Glacier Bay bequeathed to us by Vancouver in the history of his voyage round the world.

According to his account, the Muir Glacier then occupied nearly the whole of the bay now taken up by the sea. Later on, when Wright thoroughly explored the bay, he obtained undeniable proofs of the enormous extent of the glacier at an earlier period. Certain rocky islets near the opening of the bay, at fifteen miles' distance from the glacier's present front, show undoubted signs of having been formerly covered by glacier ice ; while on the cliffs round the bay, at 3,700 feet above the sea, striated rocks attest the action of the glacier that once filled the valley up to that height.

A WALK ON THE MUIR GLACIER.

The *City of Topeka* dropped anchor among the icebergs a short distance from the glacier's frontal wall, and the passengers were landed where a path traced in the narrow and easy moraine afforded easy access to the frozen plateau. Here we were struck by the vastness of the glacier bed ; but the view is far more imposing from the sea than from the dirty ice, close to the bare, gravelly ridges of the moraine. Among

to the bottom of the ravine in the shape of ice. Now, three conditions may ensue : when the quantity of ice formed above exceeds the yearly amount liquefied below the limit of perpetual snow, the glacier increases in bulk, and its terminal front is pushed forward ; when, on the other hand, the quantity of fresh ice balances the quantity melted, the bulk of the glacier is unchanged, although its downward motion persists ; but when less ice comes down from the upper snow-fields than the amount melted below, the glacier's bulk is necessarily diminished. This diminution is more marked in the terminal front than elsewhere, and consequently, the snout seems to have receded. But this, apparently, retrograde movement does not interfere with the glacier's descent, for this continues without ceasing. Only, the advancing mass is no longer sufficient to entirely replace the quantity of ice converted into water.

the *crevasses* we noticed a signal-pole fixed on a pedestal, and the foremost members of the party hastened to seize it and move it a good distance higher up, convinced that they had mounted farther than any previous explorer. But they forgot that during the fortnight's interval since the last steamer put in, the glacier movement must have carried the pole down about 1,000 feet.

On returning to the shore we found a dozen Indians—men,

INDIANS IN GLACIER BAY.

women, and children—collected there, with some lynx skins and baskets of coloured seaweed for sale. They formed a typical group, squatting on the earth, wrapped in brick-red blankets, barefoot and bare-headed, with their long, smooth black hair, yellow faces, high cheek-bones, prominent jaws, slanting eyes, flat noses, and straight, thin-lipped mouths. The men had a few bristles on lip and chin ; the women's faces were smeared with a dark, shining paste, composed of grease, turpentine, and lamp-black, to protect their complexions from sunburn.

Hard by on the sandy beach were the three canoes in which these Indians had crossed the bay, and the carcase of a young seal they had killed on the way. Their light, graceful canoes are made of hollowed trunks, and they manage to give them the proper curves by filling them with water, raised to boiling-point by red-hot stones.

On leaving the Muir Glacier our course lay due south, towards Sitka. After the day of clear weather came a very prolonged

THE BAY OF SITKA.

twilight, fading in endless gradation of tones over the bay dotted with the blue and white points of the icebergs and on the lofty summits girdling the coast. The sinking sun crowned the Fairweather range with a halo of splendour before finally sinking into the sea of molten gold on the horizon, and leaving behind it only the colourless diffused light of the northern night, so fantastic and strange. The air was perfectly still, the sea without a ripple, while here and there we marked the columns of water thrown up by whales.

At 2.30 p.m., on June 20th, our seven days' voyage ended in the port of Sitka, which at that moment had a very lively aspect. There were five Government ships on coast survey and revenue service; the yacht *Aggie*, chartered by the Prince, had been at anchor for four days, and rocked gracefully beside the stumpy *Bertha*, the steamer of the "Alaskan Commercial Company," which was to transport us as far as Yakutat, taking the *Aggie* in tow.

Sitka stands on the island of Baranoff, at the far end of a bay open to the ocean, and sprinkled with rocks and small islets.

SITKA, FROM THE SEA.

The city is built on a delta of pasture-land, with a picturesque background of steep rocky heights. It has 1,200 inhabitants, is the present seat of government, and the centre of the Alaskan coast-district.[1] Salmon fisheries and tanneries constitute its trading resources. The cool climate, and the charming situation also, attract a good many visitors to Sitka during the summer. Facing the town, on the little island that guards the bay on the north, the extinct volcano of Mount Edgecumbe rises to about 8,000 feet above the sea. The Indians have made this mountain the theme

[1] The United States have only had a regular government in Alaska since the year 1884. Sitka and Fort Wrangel are alternately its seat.

of a very interesting legend, given as follows by Mr. C. E. S. Wood in his article on the Thlinkets[1] :—

"A long time ago the earth sank beneath the water, and the water rose and covered the highest places, so that no man could live. It rained so hard that it was as if the sea fell from the sky. All was black, and it became so dark that no man knew another. Then a few people ran here and there and made a raft of cedar logs, but nothing could stand against the white waves, and the raft was broken in two.

"On one part floated the ancestors of the Thlinkets, on the other the parents of all other nations. The waters tore them apart, and they never saw each other again. Now their children are all different, and do not understand one another. In the black tempest, Chethl was torn from his sister, Ah-gish-àhn-akhon (the woman who supports the earth), and Chethl (symbolized in the osprey) called aloud to her: 'You will never see me again, but you will hear my voice for ever!' Then he became an enormous bird, and flew to south-west till no eye could follow him.

"Ah-gish-àhn-akhon climbed above the waters and reached the summit of Edgecumbe. The mountain opened and received her into the bosom of the earth. That hole (the crater) is where she went down. Ever since that time she has held the earth above the water. The earth is shaped like the back of a turtle, and rests on a pillar. Evil spirits that wish to destroy mankind seek to overthrow her and drive her away. The terrible battles are long and fierce in the lower darkness. Often the pillar rocks and sways in the struggle, and the earth trembles and seems like to fall; but Ah-gish-àhn-akhon is good and strong, so the earth is safe. Chethl lives in the bird Kunna-kaht-eth. His nest is on the top of the mountain, in the hole through which his sister disappeared.

"He carries whales in his claws to this eyrie, and there devours them. He swoops from his hiding-place and rides on the edge of the coming storm. The roaring of the tempest is his

[1] *The Century Magazine*, July, 1882.

voice calling to his sister. He claps his wings in peals of thunder, and its rumbling is the rustling of his pinions. The lightning is the flashing of his eyes."

With the *Aggie* had arrived our ten American porters, powerful young fellows, picked out for the expedition by E. S. Ingraham, familiarly known as "The Major." They worked hard, jointly with our guides, all the afternoon of the 20th June, trans-

SITKA.

ferring our stores from the steamer to the yacht, which already held the Americans' equipment. By 7 p.m. the task was done, and at 2 a.m. (21st June) we made our start,—H.R.H. and our party on the *Bertha*, the guides and porters on the yacht in tow.

The *Bertha* was an old boat of about 1,500 tons, short, broad-beamed, and so very high out of water that the slightest gale of wind would set her pitching and rolling outrageously.

The only passengers in addition to our own party were two ladies making this Northern voyage in search of health. We were obliged not to steam more than five miles an hour, on account of the light yacht we had in tow, as every jerk of the cable dragged her bows under water. Dull, hazy weather prevented us from enjoying the spectacle of the grand range of summits rising from the coast to heights of some 15,000 feet and more.

The Alexander Archipelago ends at Cape Spencer, and from this point the coast-line trends north-west, bare and straight. For about 300 miles the only important inlet is the Bay of Yakutat. Small vessels can also find shelter in Lituya Bay, at the foot of the Fairweather chain; but the rest of the shore lies open, exposed to the full fury of the ocean, and so violent a surf that landing is always very dangerous and often impossible.

CHURCH AT SITKA.

This coast is commanded by the loftiest rampart that ever Nature set along a shore, no less gigantic a sea-wall than the range which comprises La Pérouse (11,300 feet), Crillon (15,900), and Fairweather (15,500).

North of the latter summit the chain becomes lower, running still parallel with the coast, and has no peaks higher than from 5,000 to 8,000 feet as far as Yakutat Bay. Here it again rises rapidly to Mount Vancouver (12,100 feet), Mount Cook (13,750), Mount Augusta (13,900), and reaches its culminating point in Mount St. Elias, 18,000 feet above the sea.

The whole of this range is merely a part of the vast mountain-system extending along the western coasts of the two Americas, and of which the partly submerged northern end forms the volcanic range (1,000 geographical miles in length) of the Aleutian Islands. The crowning peaks of this northern group, from La Pérouse to St. Elias, rise at a little distance from the sea. From an altitude of 2,500 feet and upwards they are covered with eternal snow, and thousands of glaciers flow down their slopes to the north and south, many of which reach the sea[1] or very near it.

These glaciers are of greater dimensions than any others in the northern hemisphere excepting those of Greenland. The presence of so vast an ice world in a region with the comparatively mild climate of southern Alaska is owing to the fact that no very low temperature is required for the formation of extensive glaciers, but only a very damp climate, together with the general meteorological conditions fitted to precipitate watery vapour into snow (Lyell).

Throughout this region of ice all glaciers are shrinking; their diminution probably began one hundred or a hundred and fifty years ago, and proceeds very gradually, at the rate of two feet a year in every glacier. Very slight variations in the annual amount of fallen snow, when repeated many years in succession, suffice to produce a notable increase or decrease in the bulk of a glacier. Accordingly it has been impossible, so far, to ascertain the climatic changes that produce this retrograde motion of the Alaskan glaciers, and all the more impossible because regular and well-combined observations have only been recently undertaken.

On the 22nd June we had a calmer sea, but the horizon was quite as clouded as on the previous day. We were now in the "Fairweather" waters, renowned for the great number of whales formerly captured there (between 1846 and 1851).

Mount Fairweather owes its name to the whalers, for they had observed that when this peak was free from cloud they could confidently reckon upon several days of fine weather.

[1] In Europe, glaciers come down to the sea at the 67th degree of latitude (von Buch); in Alaska at the 57th parallel (Russell); and in S. America still nearer to the Equator—at 46° 50′ lat. S. (Darwin).

We reached the entrance of Yakutat Bay about 9 o'clock p.m., and having rounded Ocean Cape, the *Bertha* and the *Aggie* came into Port Mulgrave and dropped anchor about 10 o'clock off the little Indian village of Yakutat. On sighting our vessels the natives, waving pine torches, swarmed to the beach, with savage yells, to which the barking of innumerable dogs made an ear-splitting accompaniment.

The Rev. Carl J. Hendriksen, a Swedish missionary established near the Indian village, soon paid us a visit on board, and willingly agreed to take regular observations with a mercurial barometer we left in his care, during the whole time employed in our ascent of Mount St. Elias. Rev. Hendriksen had spent eight years in this out-of-the-way corner of the world, leading a life of self-sacrifice and abnegation, and wholly devoted to the moral and physical improvement of this primitive tribe. A schoolmistress shares his labours. The entire wealth of the Mission consists in two cows, a few fowls, and a small garden-plot yielding a scanty crop of vegetables about every third year. Meat is a rare luxury, only to be had when the Indians are lucky in the chase.

The teacher told me that the Indians are not hostile, though indifferent to the school, and that several of the children show quickness in learning. The village population is somewhat over three hundred. Like all Thlinkets, they spend most of their life on the water, either engaged in salmon-fishing or hunting seal and otter.

Thanks to the missionary's active benevolence, the settlement numbers about fifty well-built houses, mostly of two storeys.

At 2 o'clock the next morning we again put to sea, bound for the western coast of the bay, covered by the Malaspina Glacier, where we were to land. The real starting-point of our undertaking was now at length before us.

SITKA

CHAPTER IV

The History of Mount St. Elias[1]

"Those who went first and opened the way are not less entitled to credit than those who came afterwards, and reaped the fruit of their predecessors' labours."—D. FRESHFIELD.[2]

MOST geographers apply the name of "St. Elias Alps" to the whole mountain system bounded by St. Elias to the north and La Pérouse to the south. For a long stretch of about 180 geographical miles these alps run parallel with the Pacific coast, and separated from the sea by a narrow strip almost entirely covered by the mighty glaciers flowing down from the range. Yakutat Bay, thrusting inland by the narrow and tortuous fiord known as Disenchantment Bay, divides the mountains into two groups, consisting of the Fairweather chain to the south, and of the Cook and St. Elias chains to the north.

Yakutat Bay is twenty miles wide at the entrance, and retains the same width for some distance inland, until narrowed by an

[1] For the authorities and sources of information used in compiling this chapter, *vide* Appendix E. The history of the first exploration of the St. Elias region is mostly summarized from Mr. Russell's accurate account in the report of his first expedition, published in the *National Geographic Magazine* of May, 1891 (Washington).

[2] *Proceedings of the Royal Geographical Society*, May, 1887, p. 16.

abrupt curve of its eastern coast as far as the opening of Disenchantment Bay, which is barely three miles wide. The greater part of the eastern coast, guarded by a string of low, wooded islands and with many natural creeks, forms a highland plateau rising from 2,000 to 3,000 feet above the sea and covered with forests. This plateau is dominated by a low mountain range, with numerous snow-fields and glaciers joining Fairweather to the south, and running round the head of the bay until it is finally merged in the Cook range beyond.

The west coast of the gulf forms the eastern flank of a great tableland, bounded on the south by the Pacific, with an almost unbroken shore-line, exposed to the full fury of the ocean surf. The Malaspina Glacier spreads over this plateau, at an average height of 1,500 feet above the sea, rising gradually to the feet of the mighty chains behind, and extending for a distance, as yet unknown, to the west of Mount St. Elias. The mighty glaciers which flow down the southern flank of the range to feed the Malaspina will be mentioned farther on. The entire region to the north of the St. Elias and Cook chains is still unexplored ; C. Willard Hayes, who has crossed overland from the Yukon basin to that of the Copper River, is the only traveller who has given any information about the great glaciers which flow to the north.

On the 20th July, 1741, Vitus Behring, a Russian navigator, discovered the south coast of Alaska, and anchored his vessel, the *St. Peter*, off the island of Kayak, 180 miles north of Yakutat. South-east of his moorings, he saw a great mountain rising from the sea, and covered with snow from summit to base. In honour of the patron saint of the day, this peak was named St. Elias. It is possible that the name was not chosen entirely on that account. Mr. Freshfield has observed that the prophet Elias seems to be the special patron of mountains wherever the Eastern forms of Christianity have prevailed. Many mountains in Greece bear the same name, and are crowned with chapels dedicated to the saint ; while the altars of Zeus on Olympus have been replaced by monasteries likewise dedicated to St. Elias. In the Caucasus there is still a tradition that when the primitive tribes were driven up into the mountains by the Circassians, the vision of the outraged saint was frequently seen on the highest peaks, and that they carried offerings to him of milk, butter, and beer. Some writers derive the saint's connection with mountains from the important part in the Transfiguration assigned to Elias by the Greek Church; whereas it is asserted by others that, owing to similarity of name, Elias succeeded to altars originally dedicated to Helios, the Sun.

Mr. Freshfield suggests that another explanation might be found in the survival of the belief attributed to the prophet's sons, who sent an expedition composed of fifty strong men in search of Elias, thinking that "peradventure the spirit of the Lord hath cast him upon some mountain." [1]

Mount St. Elias brought no good fortune to its discoverers. For three months the *St. Peter* lay in Alaskan waters, buffeted by storms, and was then wrecked by a hurricane on the coast of the Commander Islands. Behring died there with most of his crew. The few survivors wintered on the islands, afterwards succeeded in reaching the coast of Kamschatka, and finally got back to Russia.

The first measurement of St. Elias was made in 1786 by Mons. Dagelet, astronomer to the expedition round the world undertaken by La Pérouse with his two ships *La Boussole* and *L'Astrolabe.* By his calculations the height was 12,672 feet. The summit rose above the clouds; between the long chain of snow-peaks and the sea lay a great plateau which, according to La Pérouse's description, looked completely bare of vegetation, and, composed of black, calcined-looking rock, contrasted strangely with the snow-covered mountains. The Gulf of Yakutat, named "Baie de Monti" by La Pérouse, was re-christened "Admiralty Bay" by G. Dixon, who, entering it in 1787, was the first explorer of its shores, and anchored his vessel at Port Mulgrave, where an Indian village already existed with some seventy inhabitants.

[1] *Vide Proceedings of the Royal Geographical Society*, May, 1887.

A few years later, in 1792, Spain despatched two ships, commanded by the Italian captain Don Alejandro Malaspina, to seek the famous North-west Passage between the two oceans. On entering Yakutat Bay, Malaspina discovered that it was prolonged inland by an arm in which he hoped to find the beginning of the desired channel. But the boats sent to explore it found the way barred by a cliff of ice at a short distance from the mouth. They named the inlet "Puerto del Desengaño" (Disenchantment Bay), and the island in it "Haenke." Their observations fixed the height of St. Elias at 65,076 "varas" (17,851 feet); its position at 60° 17′ 35″ lat. N., and 140° 52′ 17″ long. W. (Greenwich). On Malaspina's return to Spain, he fell into disgrace and was imprisoned, so that his discoveries remained unrecognised for many years.

Another famous navigator mentioned in the history of Alaska is G. Vancouver, who, in the year 1794, explored Yakutat Bay and the neighbouring coasts with his vessels the *Discovery* and the *Chatham*. He gave the name of "Point Manby" to the headland bounding the western entrance to the bay. The plateau he described as bare ground strewn with stone, rising in a gentle and even slope to the spurs of lofty mountains dominated by St. Elias. He also noted that east of Yakutat Bay, in a creek towards the Pacific (Icy Bay), the coast seemed to consist of a vertical wall of ice.

No other account of St. Elias and its precincts is to be found until 1852, the date of Tebenkoff's report, chiefly founded on information obtained from Russian traders. Here the height of St. Elias is stated to be 17,000 feet, its position 61° 2′ 6″ lat. N., and 140° 4′ long. W., at thirty miles from the sea. Tebenkoff states that in 1839 smoke was seen issuing from a crater on the south-east flank of the mountain, and that an eruption of fire and ashes took place in 1847, contemporaneously with an earthquake experienced at Sitka. The lowlands at the base of St. Elias are described as "tundras" covered with forests and pastures, and it is added that through fissures in the sandy soil you could see a substratum of ice.

Subsequently, these fables of fictitious eruptions being collected and repeated, though with every reserve as to their authenticity, by W. H. Dall, created the belief so long prevalent that Mount St. Elias was a volcano. This theory was apparently corroborated by the curious shape of the southern crest of the mountain, which is so curved as to form a great amphitheatre resembling a real crater. Successive explorations have proved that the St. Elias group shows no trace of volcanic action. But a curious phenomenon observed by Topham may perhaps explain why certain navigators thought they saw Mount St. Elias in eruption from the sea.

Down one of the very steep gullies, about 300 feet deep, scoring the inner side of the so-called crater, there were perpetual falls of stones and detritus; and these avalanches sent up lofty columns of dust which, caught by the wind, simulated whirls of smoke. Even Topham, on seeing this effect at a distance, believed at first that it proceeded from a volcano. Mr. Russell likewise noted that great clouds of dust were sent up by the falls of shale detritus on the south face of Mount Augusta. On other occasions similar causes have led to the same mistake. In 1741 a commissioner was sent from Turin to inspect a new volcano said to have broken out in the Savoy Alps, and which proved to be simply a landslip from the Rochers de Fyz, near Servoz (De Saussure). A similar landslip in the present century led to a rumour that the extinct volcano of Mount Ararat had burst into life again. When Mr. Freshfield was on Mont Blanc in 1867, he saw a cloud of dust caused by a landslip near the Little St. Bernard Pass, fifteen miles from the spot where he stood. This phenomenon lasted for several weeks, and no spectator at a distance could possibly recognise its real nature and cause.

The next expedition to Alaska was that despatched in 1874 by the "United States Survey," directed by W. H. Dall and M. Baker, which gleaned a rich harvest of geographical and geological data, and much new information on the glacial phenomena of the region. It was this expedition which first ascertained the real nature of the plateau interposed between the mountain chains and the sea, *i.e.*, that it consisted of a huge glacier,—and named it the "Malaspina." Then, too, the Cook, Vancouver, and Malaspina peaks were identified and christened. The height of St. Elias was calculated at 19,600 feet, with a probable miscalculation of 400 feet, more or less; and the position was fixed as 60° 20′ 45″ lat. N., and 141° 00′ 12″ long. W.

By this time Mount St. Elias had won a definite place on maps of Alaska, and it is astonishing that the exceptional characteristics of the country, with such lofty mountains and glaciers of such unusual extent, should not have immediately tempted more explorers to attack those virgin peaks and penetrate to the heart of the new region. Difficulty of access must have been the chief cause of this delay. There is no commercial motive to attract vessels to this zone of forests and ice-fields, where a small native population finds the barest subsistence and where communications with other parts of the continent are few and irregular.

In the spring of 1877, Mr. C. E. S. Wood being determined to attempt an excursion to St. Elias, found no means of proceeding beyond Sitka, save by an Indian canoe. This conveyed him to Cape Spencer, at the northern extremity of the archipelago; but as the Indians were afraid to risk their little craft on the open sea, along an absolutely harbourless coast, his journey was suspended.

The first real expedition for the purpose of making the ascent of St. Elias only dates from 1886, and was organized by *The New York Times*. It consisted of Messrs. F. Schwatka, W. Libbey, and an Englishman, Lieut. H. W. Seton-Karr. They made the passage to Yakutat in the *Pinta* of the U.S. Navy. On July 17th, they sailed from the bay in Indian canoes, followed the Pacific coast to the mouth of the Yahtse River, south of St. Elias, and, at no little risk, effected a landing through the surf.

They brought two white porters and four Indians. Keeping to the eastern side of the extensive delta of mud, stones, and sand, intersected by numberless branches of the Yahtse, they reached the point where the river issues by a great tunnel out of the glacier, and climbed to the edge of the frozen plateau, which is covered with a thick stratum of moraine detritus.

The ice tunnel through which the river runs is about eight miles long, and ends at the foot of certain heights which the explorers named "The Chaix Hills." The course of the tunnel is indicated by a depression in the surface overhead, caused by the junction of the lateral moraines of the two glaciers, which flow down to the coast on either side of the Yahtse. The glaciers themselves actually join overhead, forming the ice roof of the tunnel. The expedition gave the name of "Guyot" to the glacier on the west side of the Yahtse, and "Agassiz" to that on the east. The latter, however, is really the western extremity of the Malaspina Glacier.

At the feet of the Chaix Hills, in the deep hollow dividing them from the Guyot and Agassiz glaciers, two swift torrents rush down, and, uniting their waters at the south end of the range, form a lake to which the explorers gave the name of "Caetani" in honour of Don Onorato Caetani, Duke of Sermoneta, at that time President of the Italian Geographical Society.[1] The river Yahtse issues from this lake only to plunge into the tunnel just described. Whenever this sub-glacial passage becomes choked with ice blocks and moraine material, Lake Caetani overflows, and then a good portion of the river makes its way towards the sea over the surface of the glacier. Once the passage cleared, the whole river again disappears beneath the ice; while the lake shrinks and sometimes disappears altogether.

The caravan first marched to the western end of the Chaix range; then (having dwindled to three men, *i.e.*, Schwatka, Seton-Karr, and one of the white porters) it crossed the Tyndall Glacier, which flows straight down the south-west flank of St. Elias, and gaining the chain of hills bounding the mountain to the west, began to ascend their slope. Schwatka came to a halt at about 5,800

[1] In the account given by H. W. Seton-Karr, and in the map of this region prepared subsequently by H. W. Topham, by some mistake the word *Castani* has been erroneously substituted for *Caetani*, a well-known name in Italy.

feet. Seton-Karr proceeded alone, and reached the top of the ridge, at about 7,200 feet, but cloudy weather and the lateness of the hour compelled him to retreat.

The enterprise was plainly impossible with the means at their disposal, and it was decided to return to the coast, sixteen miles away. On the 30th July, after some abortive attempts, the little band succeeded in putting out to sea, but were obliged to leave their baggage behind.

This expedition had taken fourteen days, and been favoured by exceptionally dry weather. The results obtained by it consisted of a sketch-map of the region and the first stock of reliable observations on the nature of the country and the difficulties to be overcome in exploring it.

Two years later the attempt was repeated by the English Alpinists, Messrs. W. H. and E. Topham, and G. Broke, together with Mr. W. Williams, of New York. Sailing from Sitka on the 3rd of July, 1888, in a small schooner, they reached Yakutat in seven days. Proceeding thence in Indian canoes, they landed on the 13th near the mouth of the Yahtse, about 55 miles east of Port Mulgrave, the very point where Schwatka had disembarked. The surf was not very high at the time, and the landing was made without trouble; but fifteen hours later it would have been impossible.

The explorers with their party, consisting of four white porters and six Indians, followed the same course taken by Schwatka as far as the Chaix Hills. Then bearing eastward, they climbed a glacier that girdles the base of the south-east wall of St. Elias at a level of 1,500 to 2,000 feet, and pours into the Malaspina with an ice cascade a thousand feet high. This glacier they named after Libbey. A string of low hills, connecting the Chaix range with the southern face of St. Elias, separates it to the west from the Tyndall Glacier discovered by Schwatka.

But the explorers soon perceived that it was impossible to make the ascent of the precipitous south-east flank, which rose to over 16,000 feet, and was rendered unapproachable by masses of snow

and ice, which fell constantly in formidable avalanches, sweeping the rock wall from top to bottom. Accordingly, they went back to Lake Caetani, and followed the course taken by Schwatka as far as the western side of the Tyndall Glacier (Karr's Hills), which Seton-Karr had reached. Here Broke was obliged to halt, having broken his snow-spectacles. The others re-crossed the glacier, and camped at the foot of the south bastion of St. Elias, exactly beneath the point where the ridge curves round and forms the amphitheatre which was mistaken for a crater. After one failure, they managed to win the crest of the ridge. It was covered with thick snow, over which they proceeded, cutting steps in the steeper places.

About 2 o'clock p.m. they reached the northern side of the amphitheatre, where the ridge ceases to bend and runs almost straight up to the summit. Their aneroid and "boiling-point" thermometer registered a height of 11,460 feet. Here the ridge rose in a very steep cliff 1,500 feet high, and almost entirely coated with blue ice, which would have required several hours of step-cutting. Beyond, at about 7,000 feet above this cliff, soared the summit, capped with snow, and bordered by a huge cornice.

It was hopeless to think of winning the peak that day, and, very reluctantly, the explorers returned to their camp. The point of the ridge which they had reached, and which, when seen from below, appeared to be a separate peak dominating the amphitheatre to the north, was named by them "Hadon's Peak."

The walls of this amphitheatre are almost vertical, composed of stratified rock, striated and furrowed by the continual falls of stones and detritus produced by the process of disintegration. The bottom of the hollow is filled by a glacier which flows out through an opening to the east. The whole extent of the south-west face of St. Elias was visible from the ridge, and seemed no less inaccessible than the south-east face. No rocks showed any trace of volcanic action.

The expedition employed five days in regaining the coast, and reached Yakutat, the 10th of August, after nearly a month's absence.

The time had come for scientific societies to reinforce private enterprise in the work of exploration. With the larger funds at their disposal they could afford to either assist or even to actually fit out expeditions on their own account for the purpose of surveying the country, and studying its interesting natural phenomena.

In 1890, the United States' "National Geographical Society" and the "Geological Survey" united to send an expedition to the St. Elias region, under the direction of Professor J. C. Russell, a well-known writer on glacial geology, and one of the explorers of the Yukon basin.

Mr. M. B. Kerr was to accompany him as topographer to the expedition.

Professor Russell made the best use of the lessons learnt from the experiences of former explorers. His expedition was organized at Seattle. Supplies for three months were packed in hermetically sealed tins to prevent them from being spoiled by the excessive dampness of the climate, during the long journey over snow and ice. The light equipment, including tents, waterproofs, blankets, special petroleum stoves, and a good stock of fuel, would have enabled the expedition to spend many days at a high level, above the line of vegetation. It had been found that the Indians accompanying former expeditions, while very useful in the lowlands, were totally unfitted for mountain work. Accordingly, Professor Russell enlisted six American porters at Seattle, led by J. H. Christie. Finally, the expedition was supplied with the necessary instruments for topographical survey.

The party started from Seattle on the 16th of June, and reached Port Mulgrave on the 27th, making the passage from Sitka to Yakutat on the U.S.A. *Pinta*. Early on the 28th they put to sea in canoes, skirting the east side of the bay between the islands and the shore, crossed the mouth of Disenchantment Bay on the 1st of July, and landed at the north-west corner of Yakutat Bay, at the base of the eastern spurs of the Cook chain. Although so far from the mouth of the bay, they found the beach lined by white breakers, luckily not formidable enough to prevent landing in ordinary weather. Numerous icebergs, fragments of the glaciers which thrust their snouts into the waters of Disenchantment Bay, are caught by the wind and the currents, and driven in upon the beach at the head of Yakutat Bay. In great storms, the waves, rushing into the bay, lift the floating masses, and toss them far up on the shore. The clashing of the blocks of ice, as they collide, joined with the howling of the wind and the roar of the sea, creates an appalling tumult.

After leaving this first camp, Russell took a westerly course, scaled the successive southern spurs of the Cook chain, and crossed the snouts of many confluents of the Malaspina Glacier, which flow down between these spurs. Here the ice was almost concealed under a stratum of moraine, consisting of detritus pebbles, together with boulders of every size. Many small lakes occur in these frontal moraines, and streams of water, which issue from ice caves and run in the open for some distance, before disappearing into other tunnels.

Russell named these glaciers, going from east to west, the " Black," " Galiano," " Atrevida," " Lucia," " Hayden," and " Marvine." In the centre of the frontal moraine of the latter, a jutting spur forms an island covered with firs, which shelter a luxuriant vegetation gay with myriads of flowers. Russell christened this " Blossom Island," and fixed a base-camp there with a store of food, to be carried up later as required by detachments of porters.

From the shore to " Blossom Island " was a thirty-one days' march. The porters had to make many journeys from one camping place to another to carry forward all the equipment. Meanwhile, Russell and Kerr had been occupied in geological investigations and topographical surveys, which often led them far out of their definite track. Everywhere Russell discovered evidence of the shrinkage of the glaciers; ledges in the rock-walls of the various valleys indicating the height formerly reached by the ice-beds, some 700 to 800 feet above their actual level.

Marvine Glacier, at the foot of which stands Blossom Island, flows direct from the south face of Mount Cook, and is bounded to the west by a long spur that projects far into the Malaspina, bearing from north-east to south-west. This spur is cleft midway by a deep ravine. The southern half, thus quite separated, forms as it were a distinct chain, about eight miles long. Russell named this the "Hitchcock Range," and the cleft "Pinnacle Pass," on account of some sharp peaks which dominate it to the north. The pass is barely 200 to 300 feet wide, and is 4,000 feet above the sea. Two glaciers flow down from it: one, an affluent of the Marvine, steep and much crevassed, running east; the other flowing westward at a gentler angle, and falling into a huge ice-stream of far larger dimensions than the rest of the Malaspina affluents, to which Russell gave the name of "Seward Glacier."

The vanguard of the expedition crossed Pinnacle Pass on the 5th August, after a night's halt on the Marvine Glacier, where they had been in serious danger from a fall of stones caused by a violent rain-storm. Bad weather, and the necessity of awaiting the arrival of stores from the lower camps, confined Russell and Kerr several days to the neighbourhood of the pass. They gave the name of "Mount Logan" to a mighty peak north of the Augusta chain; and two peaks, rising on the northern branch of the Cook range, were called "Mount Owen" and "Mount Irving." Between August the 13th and 16th, Russell effected a passage from the "Seward" to the "Agassiz" Glacier by following a depression in the spur (Samovar Hills) dividing one from the other. The two snow-domes which crown this col won for it the name of Dome Pass (4,300 feet). Here the explorers saw before them an open valley filled by a glacier that flows into the Agassiz in a great cascade of *séracs*. After crossing this, they looked straight up to Mount St. Elias, with no intervening obstacles to impede the view, and the route to the summit seemed clearly traced. The valley they had entered was formed by two ridges of the mountain, and was shut in at the end by a wall which led to a spacious col between the cone of St. Elias on the south and a lower summit to the north. To the latter, and to the glacier filling the valley, Russell gave the name of Newton. The divide was connected with the peak of Mount St. Elias by a long ridge which seemed to offer a comparatively easy passage. But the Newton Glacier, furrowed with numerous wide *crevasses* and formidable cascade-like *séracs*, was prepared to oppose a fierce resistance to the desired conquest. On reaching the second cascade after several hours' struggle through that labyrinth of ice-blocks, and among enormous *crevasses* barring the way in every direction, they were compelled to take a very perilous route skirting the south wall of the valley, where avalanches of snow and ice fall down from the slopes above with great frequency. Half-way up the glacier, a spur projecting some distance across the valley presented an apparently insurmountable obstacle. After repeated attempts, they contrived to hitch a rope over the crag of a vertical cliff, and were thus enabled to climb to the second Newton plateau and haul up their packs.

One more ice-fall alone separated them from the terminal wall mounting to the col, when bad weather joined with the difficulties of the glacier in checking the progress of the little band. During the whole of August 22nd and 23rd, it snowed incessantly, so that Russell and Kerr, who had started from the highest camp to attack the peak, were obliged to descend to the foot of the cliff (Rope Cliff) to which they had fixed their cord. When the weather cleared, on the 25th, they resumed the attack, while the two men who had come up with them went down to fetch supplies from a lower camp. After several hours' march, Russell and Kerr discovered that they had very little petroleum left. This was a serious blow at a level where, without fuel, water was not to be obtained. Fire was needed also to enable them to warm themselves with hot tea or coffee and bake their raw flour. In this emergency, Russell decided to push on alone as far as the point whence the snow-storm had driven them, and to wait there while Kerr dashed down to catch up the porters and get the petroleum from them. As evening fell, Russell halted, tired out, rigged up his tent and went to sleep. During the night, it began to snow again, and continued for two days. The flakes fell thickly and continuously until the tent was half buried, the sides bending in beneath the heavy weight. Russell had no longer room to lie within, and was forced to hollow out a chamber in the snow. Having no petroleum, he contrived to make a feeble fire by means of a rag dipped in melted bacon. For six days he remained alone in the waste of snow; then, as the weather had cleared and none of his comrades appeared, he went down the mountain to seek them, leaving his tent behind. After a few hours, he met the porters coming up, guided by Kerr. The blinding snowfall had detained the latter at Rope Cliff during three whole days, with neither shelter nor fuel, and, for the last thirty hours, no food save raw flour. The men only joined him on the 29th of August.

There was nothing for it but to bow to fate. In spite of Russell's tenacious and often rash courage, there was no longer any hope of conquering the peak. The weather being almost continuously bad, the newly fallen snow remained so soft that getting through it was very slow and exhausting work. Waterproofs were an insufficient protection from the damp, and both clothes and blankets had been soaked through for days. The transport of supplies was also becoming very difficult. Besides, the glare of the snow had affected the eyes of most of the party, and in spite of their smoked spectacles, they could hardly endure the light.

The return journey began on the 1st of September. Kerr, who was broken down by the days and nights he had spent without shelter in the snow, went straight back to the coast. Russell, however, made one more excursion up the Seward Glacier to the north-west spur of Mount Owen, and another from Blossom Island, some miles' distance on the Malaspina, for the purpose of studying its glacial phenomena. The rain was almost incessant during his whole descent. He reached the shore on the 15th of September. On the 23rd he embarked in the *Corwin*, sent expressly to convey the expedition back to the United States.

The interest roused by Russell's scientific report on the region he had inspected was so great that the "Geographical Society" and the "Geological Survey" decided to despatch him thither again in the following year, in order that he might collect additional scientific data, extend his field of exploration, and renew the attack on Mount St. Elias.

Accordingly, on the 4th of June, 1891, Russell and six white porters put in to Yakutat on the U.S.A. *Bear*. This time he resolved to follow the example of Messrs. Schwatka and Topham, by landing at a point of the coast nearer Mount St. Elias by the mouth of the Yahtse River. But while disembarking, a heavy disaster occurred. Either the surf was stronger than usual, or the *Bear's* boats were less fitted for landing than light Indian canoes. Be it as it may, the first two boats were capsized by the breakers, and six of the party drowned. One of Mr. Russell's porters was among the victims. On the following day the attempt was renewed, and this time with success. Russell went on shore on the 8th of June.

By the 10th all the baggage had been carried to the edge of the Malaspina moraine. This was covered by so dense a forest that they were forced to work with hatchets for a whole day to cut a passage. By the 20th of June everything had been conveyed across the moraine to the brink of the bare ice. During the work of transport, Russell spent several days on the Chaix Hills, studying their geological formation and building a sledge to facilitate the porterage of stores over the snow. Then pushing on to the extreme south-west corner of the Samovar Hills (July 12th), he re-ascended the Agassiz Glacier to the foot of the ice-cascade which terminates the Newton Glacier. This he had reached the preceding year in coming down from the Dome Pass.

He was familiar with the route beyond this point up the Newton Valley, and aware of the difficulties to be encountered. Climbing all the ice-cascades in succession, and crossing the intervening plateaux, he came to the foot of the last cascade, where he had on the previous occasion passed those six days of solitary confinement, in danger of being buried under the snow. This last difficulty also overcome, he reached the upper amphitheatre of the glacier by the 20th of July, and planted his

MOUNT ST. ELIAS FROM LIBBEY GLACIER.

(*From a Photo by J. C. Russell.*)

upper camp there at the height of a little over 8,000 feet. It had taken him eight days to attain to this level from the foot of Agassiz Glacier, and almost six weeks from the coast.

He and his two porters stayed twelve days at this camp, with almost continual bad weather, so that he had only one opportunity, on the 24th of August, of attempting the ascent. Starting with his men at 2 o'clock a.m. (24th August), he made for the head of the valley, where it is barred by an ice-wall rising to the divide between Mount St. Elias and Mount Newton.

This ascent was so steep that steps had to be cut nearly the whole way up, while great transversal *crevasses* added much to the difficulty of the climb. At some parts of the ascent, they had to pass under overhanging masses of ice threatening them with avalanches. Finally, at midday, the party landed safely on the col. After a short rest, they attacked the broad ridge that runs thence straight up to the summit of Mount St. Elias. But soon they grew tired. It was rather late in the afternoon, and the peak still soared high above them, although they had already climbed a great distance from the camp. To be overtaken by nightfall without any shelter at such an altitude would have involved too serious a risk, the more so as slight vapours beginning to cloud the hitherto perfectly clear sky, threatened a change in the weather. So, with the deepest reluctance, Russell was obliged to give up all hope of completing the ascent that day. It was 4 o'clock p.m., and the expedition had reached the height of 14,500 feet. Night had already fallen when they got down to their tent in a very wearied condition.

The presage of evil weather was fulfilled on the following day. Russell had planned to carry the tent and the supplies to the divide, being convinced of the impossibility of covering in one day with the force at his disposal, and without intervals of rest, the distance from the base-plateau to the top. The weather having slightly improved on the 28th, the party started off again, laden with supplies, in order to establish their station on the col. But newly fallen snow had formed a heavy layer on the steep sides of the amphitheatre, and this was now breaking into innumerable avalanches, which swept down to the valley with irresistible force. There was danger on all sides, from the precipices of Mount St. Elias and Mount Newton, and even from the col to which the party was ascending. Russell felt that it would be too great a risk to proceed, and so returned to the camp, where dense snow-falls during the ensuing days finally destroyed every hope of success.

On the 1st of August retreat was decided upon. The only digression from the downward route was a short excursion made to the Libbey Glacier and the cliffs connecting the Chaix Hills with the south front of Mount St. Elias. By the 10th the expedition had reached the shore of Icy Bay, where it had landed two months earlier. Russell stayed there a week for the purpose of measuring by triangulation the heights of the chief summits of the group.

The altitude of Mount St. Elias was calculated at 18,100 feet, with a possible error of 100 feet more or less. The expedition resumed its march on the 19th of August along the Pacific coast, in the direction of Yakutat Bay, sometimes over the pebbly beach, at other times through dense undergrowth in the woods, often fording torrents where the icy water was more than waist-high, and occasionally marching in the open over the moraine that covers the whole front of the Malaspina Glacier. Reaching Cape Manby on the 27th, the explorers turned off from the Pacific coast to follow the west shore of Yakutat Bay, and at last, on the 1st September, reached the head of the gulf, which had been the starting-point of their expedition in the preceding year.

Here Russell found an Indian canoe with a deposit of food supplied by the missionary of Yakutat, Rev. Hendriksen. He was thus enabled to make a thorough exploration of Disenchantment Bay, into which no previous traveller had penetrated to any great distance. He discovered that it winds a long way inland among the mountains, forming two sharp angles in turning from west to east, and from north to south. Three great glaciers flow down into it—the Dalton, Hubbard, and Nunatak glaciers. In Malaspina's time (1792), these glaciers entirely choked the east arm of the bay, and extended to the island of Haenke. To the south the bay lengthens into a fiord, penetrating into a large valley also formerly filled with ice from a glacier that flowed southwards, and which probably formed a great ice-sheet, similar to Malaspina Glacier on the plateau overhanging the east coast of Yakutat Bay. On the 15th of September Russell re-entered the village of Yakutat, and on the 1st of October he steamed out of the bay on the U.S.A. *Pinta*, and reached Seattle on the 21st, after nearly five months' absence.

In this brief summary of the two expeditions which have so largely contributed to the world's knowledge regarding the Mount St. Elias region, I have scarcely touched upon Mr. Russell's geological discoveries, or his observations on glacial phenomena. They are to be found in full in the published reports of the "Geographical Society" and the "Geological Survey." In describing the course taken by H.R.H.'s expedition, I shall have frequent occasion to refer to those works.

Meanwhile, the foregoing historical sketch will suffice, I think, to furnish a general idea of the character of the region to which we were bound, and the nature of the task we were about to accomplish, under the guidance of our chief, H.R.H. the Duke of the Abruzzi.

CHAPTER V

The Malaspina Glacier

AT 2 o'clock a.m. on the 23rd June, the *Bertha* steamed from Port Mulgrave with the schooner *Aggie* in tow. Warned by the experiences of our predecessors as to the difficulty of landing on the Pacific coast, and more especially by the catastrophe that had saddened Russell's second expedition at the start, together with the uncertainty as to the state of sea and surf on the southern shore, H.R.H. decided to disembark on the west coast of Yakutat Bay, in spite of its being several miles farther from St. Elias than the landing-place on the Pacific.[1]

We were to land a few miles north of Cape Manby, by the mouth of the glacial torrent Osar, near the mouth of the bay. From that point H.R.H. hoped to find a tolerably easy track up to the Malaspina plateau, and thence to cross the great glacier rapidly, conveying all the camp material and a sufficient supply of food on the four sledges comprised in our equipment. Previous

[1] H.R.H. had hoped, at first, to be able to land on the southern shore of the plateau at a point where the force of the breakers was broken by a sheltering sand-bank, marked on the chart of the U.S. *Coast Survey* (North-West Coast of America, Sheet No. 2) as lying off the coast opposite the mouth of a small creek due east of Icy Cape. But we ascertained at Yakutat that no such sand-bank existed, and that the coast is unsheltered throughout its length.

explorers had always tried to land as near as possible to the spurs of the mountain, in order to avoid camping on the open glacier, and continue to make use of the fuel ready to hand on the thickly wooded lower slopes as long as possible. But what with prolonged marches over the loose, sharp-edged stones of the moraine, and considerable waste of time and strength involved in going to and fro to carry up heavy loads of supplies, they had paid a heavy price for these advantages.

Mr. H. S. Bryant, of Philadelphia, with a party of seven men,

WEST COAST OF YAKUTAT BAY.

had landed ten days before us at the same point for which we were bound, also with the purpose of attempting the ascent of Mount St. Elias. At Yakutat we had taken on board one of the Indians who had crossed the bay with Mr. Bryant, thinking he might be of use in identifying the landing-place.

We were barely one hour from port when the *Bertha* was stopped in the middle of the bay by a thick fog. So we passed the whole morning fuming at the delay. Finally, about 2 o'clock p.m., the air cleared a little and allowed us a glimpse of the Malaspina coast line a few miles off. Straight before us lay a low beach, white with breakers, and backed by the dark rampart of the Malaspina moraine, some 300 feet in height and flecked with snow. Farther inland, under a thick bank of fog, we could distinguish the lower portion of the Cook chain, with great glaciers, tributaries of the Malaspina, filling all its ravines. Very gradually we approached the shore, searching for a landing-place. The Indian, who was to have acted as pilot, remained stupidly inert, and gave no sign of recognising the coast.

At 3.30 Lieutenant Cagni went off in a boat to examine the beach, and presently returned with bad news. At 600 feet from the

WEST COAST OF YAKUTAT BAY AND MALASPINA MORAINE.

shore he touched bottom with his oars, while a line of dangerous surf cut him off from land. Meanwhile we had ascertained that the current caused by the high tide had driven us into the bay during the early morning, and that we must now steer south to make Point Manby. So we steamed on, sounding continually. Scattered trees now appeared on the low coast stretching between the base of the moraine and the sea, and soon increased to dense forests near Point Manby. At 5 o'clock we finally discern the mouth of the Osar, framed by thick pine forests. Cagni again puts off in the boat, and presently signals that he has found a landing. Here we obtain our first glimpse of Mount St. Elias, distant, shadowy, and magnified to proportions so gigantic by the mist that we look up at it with astonishment mingled with awe. The boats immediately put out from the schooner, and with these and a large boat, kindly lent us with her crew by the captain of the *Bertha*, our cases of stores are rapidly landed. The first crew ashore stand waist-deep in water, ready to haul up each boat as it rides in on the crest of the surf, and so the landing is accomplished

TALL GRASSES ON THE BEACH.

without accident, and all the baggage arrives safe and dry. H.R.H. leaves the schooner about 8 p.m., and comes on shore by the last boat.

The *Bertha* now left us for Disenchantment Bay, whence Mr. Hendriksen, who came on board at Yakutat, had promised to send us some Indian hunters to help in carrying our stores to the frozen plateau. The *Aggie* meantime sailed for Port Mulgrave, where she was to remain in harbour during our absence, with orders to return to our landing-place by the 10th of August. In case of further instructions being needed, H.R.H. had requested Mr. Hendriksen to send a few Indians every five days to the mouth of the Osar, from the end of July onward.

In two hours' time the whole of our equipment is piled in the lee of a grass-grown sandhill some fifty feet in height, out of reach of the tide, and sheltered from sudden gusts of wind. We pitch our first camp on a little spit of sand, by a tributary of the Osar. All the stores and munitions are heaped about us in the utmost disorder: cases of provisions, photographic machines, medicine chests, knapsack frames, snow-shoes, sledge-runners, cooking-stoves, bags of clothing, ropes, hatchets, and a hundred miscellaneous articles. While our soup is being prepared over a gipsy fire, we strive to reduce the general chaos to some kind of order, stow away under mackintosh everything that needs protection from rain, and so on, and then about midnight seek rest in our tents.

Early the next morning (June 24th) H.R.H. left camp attended by Gonella and the guide Petigax, to prospect a route to the moraine. Meanwhile we set to work re-arranging the whole of our equipment. Pitching a tent in a sheltered part of the forest, we pack it with the reserve stores which are to be left behind—part of the photographic, scientific, and medical apparatus, some weapons, and a store of provisions in case bad weather should retard our embarcation on returning from the mountains. Accordingly, all the cases had to be opened, their contents sorted, divided, and registered. Next, the first loads had to be packed ready for the porters to carry to the foot of the moraine by whatever track H.R.H. should decide to take.

We were assisted in this work by the American porters, whom we had hardly seen before, as they had travelled with our guides on board the *Aggie*. Their Major Ingraham—a tall, lean man, about forty years of age, of robust constitution, and great force of character, who was in charge of them—proved of the utmost service to the expedition. Indeed, his active and intelligent efforts, together with the hearty co-operation of his chosen band, had no small share in its success. These ten sturdy fellows formed a queer group, such as could scarcely have been got together in any other country.

Four of them were University students; four were sailors, one of whom was a Swede, another an Italian, one gold-digger, and one poet, German by birth, who had earned his bread by teaching classics and then become a sailor. Their names were: C. L. Andrews,

CAMP ON THE WEST COAST OF YAKUTAT BAY.

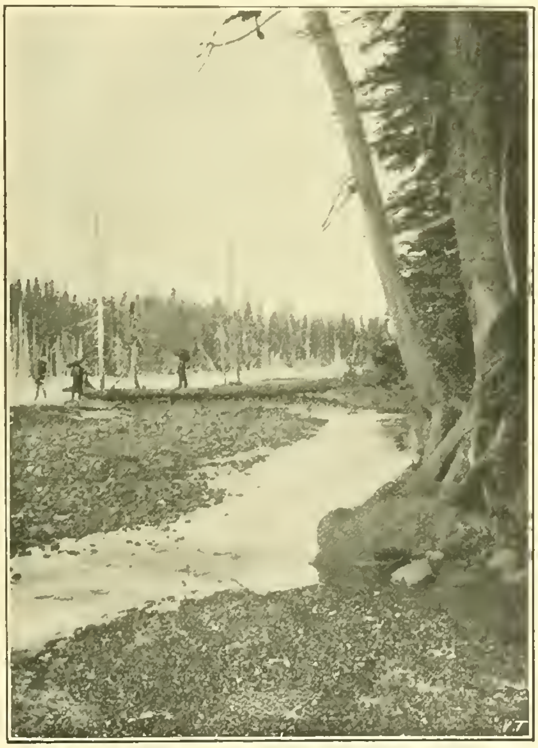
Alexander Beno, F. Fiorini, Carl E. Morford, Ralph E. Nichols, Elin Ostberg, V. Schmid, W. Steele, and C. W. Thornton.

H.R.H. returned to camp about 1 o'clock p.m., and the guides and porters immediately set off with the first loads, while we finished our arrangements amid violent explosions of wrath against the swarms of voracious mosquitoes which had tormented us incessantly from the moment we landed. All sorts of ointments were tried in vain; neither nets nor veils could save us from their stings; the pertinacious insects penetrated our clothes, up our sleeves, down our necks, and completely exhausted our patience. No wonder that writers on Alaska describe them as the scourges of the land! Instances are given of travellers being killed by them, poisoned by thousands of stings, worn out by frantic struggles with the invincible foe; of deer leaping into rivers to escape the mosquito torture (Petroff); whilst it is asserted that bears have been known to scratch themselves to death, maddened with pain. Even the Indians suffer from the stings, although they get some protection by smearing themselves all over with rancid oil.

STRAWBERRIES IN FLOWER, NEAR THE FIRST CAMP.

A surveying signal is set up on the sand-hill behind the camp; just opposite, across the little torrent running near our tents, stands a wooden hut, used as a refuge by Indian hunters. The edge of the forest is only a few yards from our encampment, beyond a slip of pasture where strawberries and dwarf raspberries are in bloom, half concealed by tall grasses and weeds. A heavy blanket of fog hangs over us all day, but, fortunately, there is no rain. Cagni has arranged his meteorological instruments between two tents, and has begun a series of observations, while Sella has pitched his dark tent in order to change his photographic plates. Evening closes in very slowly. The porters, back from their first trip, are singing songs round the fire, in the soft twilight that lasts far into the night. The deep stillness about us is only broken by the sharp cry of a stray gull or seafowl. The temperature is mild, almost always about 47–50° Fahrenheit.

Early next morning, four Indian porters arrived, sent by Hendriksen, and with their help a good part of the camp material was carried up to the base of the moraine during the day. Crossing the tributary of the Osar on a trunk bridge made by our men, we followed the right bank of the river, sometimes tramping through the sand and small shingle of its wide bed, sometimes skirting the edge of the forest, among huge fallen trees, thick brush, rich beds of fern under the firs, and over an elastic carpet of pine-needles and moss starred with bright-coloured flowers.



THE OSAR STREAM.

The Osar is one of the many streams issuing from the Malaspina channel, seaming the belt of land between the glacier and the sea, depositing great masses of glacial detritus by the way, and sometimes burying in their *delta* whole tracts of forest. Most of the larger streams come down from the south flank of the plateau, and pour into the Pacific so great a volume of muddy water that the sea is discoloured for several miles' distance from the shore, and at more than a mile out the surface of the ocean consists of fresh water. The biggest of these rivers is the Yahtse, whose delta has now completely filled up a bay that existed in Malaspina's and Vancouver's time (Icy Bay), and of which the record is preserved in a legend of the Yakutat Indians.

These rivers issue from the glacier either in a single body of water, or in several branches, some gushing out at the base of the bastion formed by the moraine, others from the ice-wall itself, at different heights, dashing down from ice caves in grand cascades. Occasionally, after running through a long series of underground passages from the upper valleys to the coast, these torrents are forced to the surface at such high pressure that they shoot upwards like colossal fountains with huge columns of spray. Whatever their origin, they generally divide into numerous branches between the moraine and the sea, and after intersecting the forest in every direction, unite in one or more great streams before reaching the sea. Fortunately for us, the Osar comes down from the moraine almost undivided, and so we are spared the trouble of fording icy floods often of very difficult passage from the strength and depth of the current. Foreseeing obstacles of this nature, we were provided with india-rubber trousers coming up above the waist, and joined to high waterproof wading boots. But these were only brought into use on the preliminary march by H.R.H. and his party in crossing the river to explore the left bank, where they found traces of Bryant's first camp.

It is difficult to give an adequate idea of the luxuriant vegetation covering the narrow strip of land between the beach and the moraine. The forest begins at a few yards from the sea, edged by groves of undersized trees—such as alder, ash, small firs, dwarf poplars, and a few willows. The rank grass all about is a perfect carpet of flowers, interspersed with flourishing plots of strawberries and raspberries (*Rubus articus*). But just beyond the fringe of scattered greenery, we come to the real forest. Here the branches of mighty firs, draped with moss and lichen, meet overhead in so thickly tangled a canopy that hardly one ray of sunlight pierces through it. Underneath, the air is that of a damp hot-house, and all the intervening space is filled with innumerable varieties of shrubs; ferns, six to eight feet high (*Asplenium*), *fungi*, and myriads of flowers jewelling the soft, spongy layer of mosses and lichens that carpets the whole forest-floor.

It is too early in the season for fruits and berries; everything

OSAR STREAM AND FOREST.

is in full blossom: currant and gooseberry bushes, and a tall plant like celery (*Archangelica*), with towering white flowers, of which the Indians eat the leaves; and here and there the humble whortleberry (*Vaccinum macrocarpum*), as yet without berries. The devil's-club (*Panax horridum*) is a formidable, prickly plant, whose wide, flat leaves are thickly set with thorns, and whose stems crawl on the ground for a bit and then shoot up to a height of ten to fifteen feet. It is easy to stumble over these creepers, and get painfully scratched by the fall. Low branches and prostrate trunks make the forest impenetrable except by slow hard labour with the axe. Hawks, ravens, magpies, flights of wild geese, ducks, gulls, and small birds add a note of cheerfulness, and complete the picture of luxuriant life.

Our march followed the curves of the Osar in a north-westerly direction. The ascent from the beach to the moraine—about three miles' distance—is very slight, hardly rising 150 feet. On the river sand and at the foot of the moraine we found many large bear-tracks; but we were too numerous and noisy to have a chance of surprising this big game. There are, at least, two varieties here—the brown and the silver bear, also known as the St. Elias bear. The latter is of enormous size. Mr. Russell saw two as big as polar bears, with footmarks 9 to 17 inches in width and a length of stride of no less than 64 inches.

At the point where we emerged from the forest, it ends abruptly some thirty feet from the moraine; but in many places—particularly on the south flank of the plateau—it has gradually pushed up into it, invading wide areas with firs and alders, which find nourishment in the layer of soil, detritus and moraine *débris* covering the ice, which is sometimes more than a thousand feet in depth.

Our second camp is pitched on the bank of a small torrent[1]—one of the sources of the Osar—running through the boundary of forest and moraine. Here the landscape offers contrasts scarcely to be seen elsewhere. The forest stretched before us in masses of sombre verdure, while behind us the moraine—a vision of barrenness and desolation—sloped upwards with its undulating waste of stones, mud, and sand, seamed by innumerable water-courses which have worn their way down the bed of ice. Over this, all our stores and material must be carried, up to the edge of the open glacier, which showed its white fringe of snow at a distance of about four miles, and some 300 feet above the camp. This stage proved longer and more fatiguing than the first march; and as it was impossible to cover the whole distance twice in the day, we

[1] We found many trout in the waters of this torrent.

arranged to go daily once to the glacier, once back to camp, and once to a half-way point where we left our loads to be carried up the rest of the way on the following morning.

H.R.H. and the whole caravan started from camp every morning, leaving only one or two persons behind to attend to the camp and prepare our food. The loads were proportioned to our strength, ranging from 20 to 50 lbs. in weight for ourselves, from 45 to 55 lbs. for the guides and porters. The loads were strapped on light wooden frames, which distribute the weight evenly on shoulders and back, leaving the chest and breathing free, and on which packages of any shape can be easily fitted and balanced. The Indians, although undersized, carried heavier weights than our men could manage—*i.e.*, from 60 to 68 lbs.—without a word of complaint. They did not use the frames, but preferred to fasten the loads on their backs by means of two straps coming over the shoulders and crossed over the chest, a system that compelled them to walk in a stooping posture. They were shod with moccasins of undressed sealskin, with the fur inside, unfitted for tramping over this waste of sharp-edged stones, which bruised our own feet in spite of our heavy boots.

The moraine began just behind the camp and sloped gently up to the frozen plateau, forming wide hollows and high ridges, at a right angle to the line of the glacier. The layers of stones and detritus are very unequally distributed. At some points they are so thin that the ice beneath shows through; at others they cover it thickly with boulders and splinters of rock in jumbled heaps. Big stones, three feet and more in diameter are generally found lying at the base of steep ridges, others being poised on the top, ready to fall with the melting of the ice they rest upon. In the wide hollows between the ridges, the surface of the moraine is very uneven. There are numerous small lakes, almost circular, either without any outlet or else traversed by torrents, and varying in size from mere pools to stretches of water exceeding 300 feet in diameter. Some lie on the surface of the moraine, others at different depths beneath, and these latter occupy funnel-shaped cavities with banks 60 to 70 feet high. The water is dark and turbid, owing to the sand, mud, and stones continually falling from the slopes above. Torrents loaded with sediment pour from ice tunnels, churning the pebbles beneath in their downward rush, sometimes disappearing again in the depths of some fissure before finally bursting forth from the moraine.

The slopes being perpetually, if slowly, modified by the melting of the ice and the glacier's rate of motion, the torrents often change their course, forming new channels, while their old beds may be traced by the rounded pebbles, which contrast with the sharp-cornered stones peculiar to the moraine.

TORRENT ISSUING FROM AN ICE-CAVE IN THE MALASPINA MORAINE.

New lakes are formed and old ones emptied, by the creation of fresh outlets, or the opening of new *crevasses* in the ice beneath, leaving the fine sand of the bed exposed to view. Thus, the entire surface of the moraine is continually shifting and changing, moving and turning over the masses of stone, breaking them into ever smaller fragments, and finally crushing them into fine sand and mud. During the hot hours of the day, when the ice melts most rapidly, you hear the continual crash of falling stones, and the whizzing sound of detritus sliding on icy slopes, mingled with the murmur of torrents, the dash of cascades, and the muffled reports caused by the cracking of the ice.

In our first marches over the moraine we often went through the surface to our knees or higher in the dense mud, which in places covers whole tracts of ice, or again forms actual mud-torrents which are not to be detected at once, as they are of the same colour as the moraine, and are studded with big boulders which float on the viscid surface.

Every part of this stony desert presents the same characteristics. Its general aspect, indeed, is so uniform that it is not easy to follow the same track twice. Only after repeated journeys over the moraine were we able to recognise this or that big rock, and use it as a landmark. We were following the general line of the greater ridges in a north-westerly direction. Between their extremities and the glacier itself lay a depression, beyond which a final slope of moraine led up to the frozen plateau. To this we climbed by a gully filled with snow, and deposited our loads on a small platform of ice covered by a thin layer of stones, close to the edge of the snow overlapping the glacier.

The whole front of the Malaspina, along the Pacific coast and Yakutat Bay—about 80 miles in extent—is girdled by a belt of moraine 4 to 6 miles wide, and everywhere of the same general character as that which we have described. Nevertheless, the southern edge of the glacier does not finish in an easy slope, as on the edge facing the bay, but ends suddenly in a steep cliff some 150 to 300 feet high.

During these first days of hard labour, we were favoured by the weather; for although the early mornings were usually so foggy as to shut off the view in every direction, the afternoon hours were warm and sunny. Our evenings in camp were enchanting after the long day's toil up and down the moraine. Including the Indian porters, we form a party of twenty-five, and our camp is very lively. Our ten tents are pitched near together in groups of three or four, and all our different tasks are carried on outside them. There is a cross-fire of shouts and orders to the men; regular strokes of the axe resound from the neighbouring forest, where a guide is cutting wood, now and then accompanied by the melancholy cry of a small bird (the *Zonotrichia coronata, Pallas*), which has three distinct notes with a curious rhythm. Some of the men are attending to the fires, others cooking, hanging out the wash, mending clothes, or putting things in order, while a few lie stretched on the ground enjoying a quiet chat.

Our four Indians, small, thick-set men, are so exactly alike that they seem turned out of the same mould. The development of arms and chests is exaggerated in comparison with the rest of the body, owing to the constant work at the oars entailed by their life on the water.

They either sit together in a separate group, patching their moccasins, or loaf round the camp with contented, smiling faces, peeping inquisitively into the tents and speaking incomprehensible words to us in their guttural tongue, full of *l*'s and *k*'s. One of them, however, knows a little English, and acts as interpreter to the rest. Their language has lost nearly all its special characteristics. Owing to frequent contact with French and Russian travellers, sailors, trappers, and whalers, these Indians speak a jargon known as "Chinook," now common to all the aborigines of the region and long used as the language of commerce on the coast of British Columbia, Oregon, and Washington State.[1]

The constant substitution of *l* for *r* and of *p* for *e* gives the dialect a certain infantile stamp.

One honourable trait of the Indians' character is honesty. They steal nothing—not even food ; and this verdict is confirmed by every one who has employed them. All expeditions, such as our own, have had to leave stores of provisions, tents, etc., in spots easily to be discovered by the Indians; yet these *caches* are always found undisturbed and with no single article missing.

By the evening of the 29th June, the whole of our baggage had been carried up to the edge of the plateau, about 500 feet above sea-level. Six days' work had been required for this portage from the shore.

The weather was cloudy, and the misty atmosphere seemed to

[1] F. N. Hibben & Co., of Victoria, have published a vocabulary of this jargon, entitled *Dictionary of the Chinook Jargon or Indian Trade Language of the North Pacific Coast.*

increase the vastness of the dead-white level stretching away to the horizon in front of us. The temperature was almost down to 32°. We cleared a patch of ground of its biggest boulders, pitched our tents on the layer of detritus covering the ice, and, as it was impossible to plant the poles in the hard ice, we made the ropes fast round the biggest rocks at hand.

This was our first camp without a fire. Our soup was cooked by the petroleum stoves. The Indians now left us. H.R.H. had commissioned them to fetch another ten days' supply of food from

CAMP ON THE SUMMIT OF THE MORAINE.

the depôt left on the shore, in order that the caravans told off to supply our successive camps might be spared the necessity of going down to the sea.

We were at the east side of the plateau, on the part of the main glacier discovered in 1874 by the hydrographic expedition under Messrs. Dall and Baker, and to which they had given the name of Malaspina. Later on, Russell embraced both the Agassiz and Guyot Glaciers, discovered by the Schwatka expedition, under this name. The latter names he previously applied exclusively to tributaries from the St. Elias and Cook chains.

According to Mr. Russell's view, the Malaspina belongs to a class of glaciers designated by him "Piedmont" glaciers, to be distinguished from the "Alpine" type, consisting of affluents flowing down into valleys.

Delineated in this fashion, the Malaspina is divided into three wide lobes, which are merely the widened snouts of the great glaciers which flow down to the plateau from the mountains. The eastern division, chiefly fed by the Seward Glacier, has a general movement from west to east, and, at one point, pushes down to the Pacific Ocean, the edge of its frontal moraine dipping into the sea for an extent of four miles along the coast. The central portion is chiefly fed by the Agassiz Glacier. It flows south-west, and is

AT THE EDGE OF THE MALASPINA GLACIER.

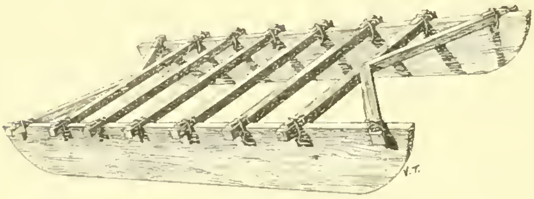
bounded throughout its course by forest and moraine. Lastly, the western lobe, formed by the spreading of the Tyndall and Guyot Glaciers, runs southwards, thrusting out into the ocean a sheer cliff of ice 300 feet in height, known as Icy Cape. Huge fragments of ice are almost perpetually breaking off and falling into the sea with thunderous reports which are heard twenty miles away. Two great moraines start from the extremity of the Samovar Hills, and run into the frontal moraine between the lobes of the Malaspina.

This frozen plateau is of such enormous extent that figures almost fail to give an exact idea of its dimensions. It stretches from Yakutat Bay for more than 70 miles to the east, measures from 20 to 25 miles in width, and its surface extends over more than 1,500 square miles. Mr. Russell has proved that the plateau on which the glacier rests owes its formation to two causes: first, to the enormous quantity of sediment deposited by the water beneath the glacier and at its front; secondly, to the gradual rise in the elevation of the whole of this region, shared by the coast. In this way the size of the plateau is continually on the increase, so that the bay which still existed to the east of Icy Cape a hundred years ago is now reduced to an insignificant cove.

Various indications led Mr. Russell to conclude that the Malaspina Glacier is gradually shrinking. He infers this from the immobility of the margins, which are overgrown with vegetation, and from the presence of large tracks of long-abandoned moraine deposits in the thick forest. The uniform distribution of these deposits over the soil proves that the process of shrinkage has been very slow and gradual. Besides, the east rim of the glacier, towards Yakutat Bay, gets thinner and thinner as it nears the edge in a gentle slope covered with a uniform layer of moraine, characteristics quite opposed to those observed in the fronts of growing glaciers.

Mr. Russell records the disappearance of two capes formerly existing on the Pacific coast (Cape Riou and Cape Sitkagi), formed by the advance of the glacier into the ocean. This change, however, may have been partly brought about by the growth of the plateau and the disappearance of certain inlets of the coast, which has consequently become rectilinear. There has been a recent advance of the glacier at two points: near the Chaix Hills and in the vicinity of Point Manby, where the ice has travelled about 1,500 feet into the forest, and uprooted a great many trees. These forward movements may have been produced by variations of declivity, caused by upheaval of the soil, which have altered the conditions of the glacier's downward flow. Possibly, at other points, the same reason may have caused the edge of the glacier to remain stationary, or even to shrink.

The glacier before us was, apparently, quite level, covered by a thick stratum of snow, and with no visible *crevasses*. Russell, on the contrary, in 1891, had found the edge of the glacier already bare of snow, and the moraines uncovered, to a great extent, as early as the 20th of June.

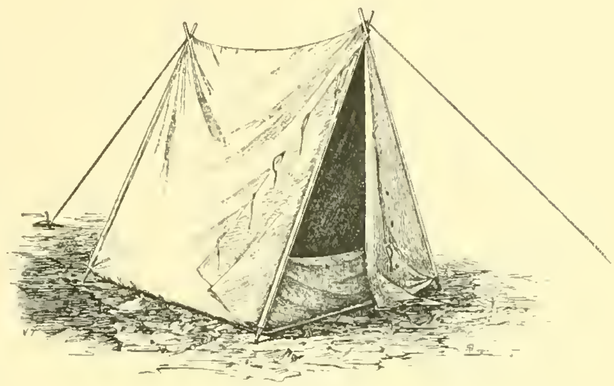


SLEDGE.

Putting together the sledges, and testing their capabilities, proved very tedious work. We possessed four sledges, measuring 5 and 7 feet in length. They had two vertical wooden, iron-shod runners united by cross-bars, the ends of which were fitted into the upper edge of the runners and secured in place by several turns of rope passing through holes in runner and cross-bar. Two small wooden rods fixed obliquely at both ends of the sledge, between the centre of the outer bars and the runners, kept the whole framework tight. These strong and very heavy sledges were more adapted for travelling upon bare ice than upon snow, where the narrow runners, only about one inch wide, sank deep, and caused great increase of friction. This defect was partly remedied by widening the runners by means of slips of wood fixed to their sides. Another fault discovered on the very first trial of these sledges, heavily loaded, was that the runners bent outwards from the slackening of the ropes binding them to the cross-bars. Accordingly, all the fastenings had to be altered, and tightened by wedges firmly driven in at the crossing points of the ropes. This device enabled us to load each sledge with an average weight of about 750 lbs.; therefore the whole material carried forward from the moraine amounted to 3,000 lbs. weight.

LOADED SLEDGES ON THE MALASPINA.

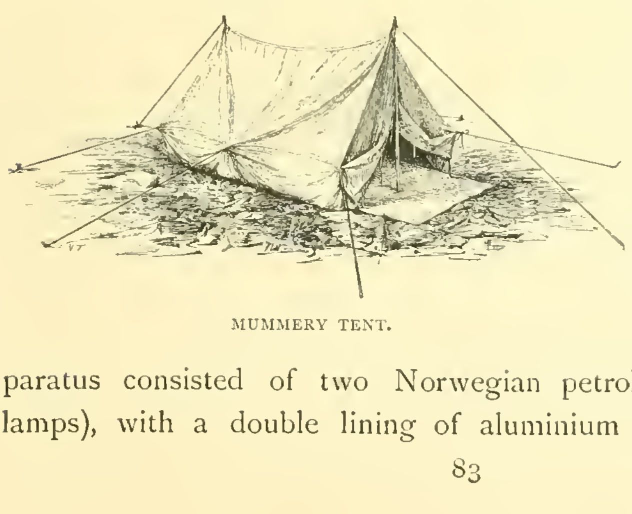
The loads comprised :—Five tents of green, waterproofed linen cloth, all furnished with floor-pieces stitched to the flaps. The three larger tents were 7 by 7 feet, and of the pattern suggested by Whymper, the two smaller ones —6¼ by 4 feet—on that of Mummery. We spread a piece of oilcloth under each tent.



WHYMPER TENT.

H. R. H. occupied one of the Mummery tents ; the rest of us two of the Whympers, while the third was allotted to the guides. With eider-down sleeping-bags, covered with stout canvas, and placed on light folding iron bedsteads, standing a span high from the ground, we were able to defy the cold at night. The guides had from the beginning preferred to reject the luxury of bedsteads, and were quite satisfied with their sleeping-bags.

The scanty space between the beds in each tent was carpeted with a thick rug to prevent our nailed boots from piercing the oilcloth. The whole camp equipment, including our bags of clothing, waterproofs, woollens, and extra shoes for the whole party, weighed 996 lbs.



MUMMERY TENT.

Our kitchen apparatus consisted of two Norwegian petroleum stoves (Primus lamps), with a double lining of aluminium to protect the flame from the wind and support the pots and pans, which were of the same metal. All the utensils fitted one into the other, so as to take little room and be easy to pack. We had also two small spirit-stoves, which could be kept alight on the march in order to melt snow for our broth or tea. All the kitchen apparatus, and utensils included, weighed 64 lbs.

The photographic baggage, comprising two *camera obscuras*, sensitive plates, black tent, etc.; meteorological instruments, medicines and other accessories, such as ropes, aluminium flasks, knapsack-frames and snow-shoes, formed together a weight of 235 lbs.

We started from the moraine provided with sixteen rations of food, each of which, packed in a hermetically sealed tin and a canvas bag, was 52 lbs. in weight, and contained one day's supply of everything required for the maintenance of ten persons, viz., of ourselves and the guides.[1]

The supplies for our American porters had been laid in by Major Ingraham at Seattle. They were provided with three white linen tents of the same size as ours, but without flooring. The men had mackintosh sheets to spread over the snow, and thick woollen blankets to keep out the cold. Their food was also packed in rations somewhat similar to ours. Their whole equipment, camp-material and provisions included, weighed 1,000 lbs.

At 1 o'clock a.m., on July 1st, the signal was given for our final start from the moraine; but it was almost 3 o'clock before we had broken up the camp, finished loading the sledges, and seen them fairly started on the immense waste of ice. It was a beautifully clear night, and half an hour later, although the sun had not yet risen, there was enough light to distinguish every detail of the view.[2]

To the right, great bulwarks of the Cook chain run down bounding wide valleys filled with glaciers. Above these soars the majestic summit of Mount Cook, covered with snow from

[1] For full details of our equipment, *vide* Appendix A.

[2] *Vide* the panorama at the end of the volume.

head to foot. Only here and there, on some almost sheer cliff, a patch of black rock serves to accentuate the form of the huge pile, whose irregularities are not discernible in the scattered, shadowless light. The summit of the mountain forms a long crest capped by three lofty white domes, of which the central one rises to an altitude of 13,750 feet, and by a few lesser peaks.

At the feet of these lies the mouth of the Marvine Glacier, flanked to the right by the isolated promontory of Blossom Island. Beyond this, towards the south-west, the east side of the Hitchcock chain stretches before us, a mass of sharp ridges and peaks, from which three great glaciers and several of lesser bulk flow down to the Malaspina. Farther on, the line of bastions seems to be interrupted for a considerable distance, and a faint white line indicates the ice fall by which the Seward Glacier pours into the Malaspina from its great basin between the Hitchcock and Samovar chains.

Above the cascade rise two other imposing peaks, the Augusta (13,900 feet), and the Malaspina, of slightly inferior elevation.

The projecting spur of the Samovar Hills partly hides the mouth of the Agassiz Glacier; and far above towers the isolated pyramid of Mount St. Elias. To the left of it is the sharp lower peak of Mount Huxley (11,921 feet), with a low range of hills at its base dropping westwards in the direction of the Chaix and Robinson Hills. To the right of Mount St. Elias stands the clumsy dome of Mount Newton (13,811 feet), united to Mount Augusta by a long and deeply notched ridge. The east face of Mount St. Elias, directly before us, is divided into two walls, turning north-east and south-east by a short buttress falling steeply towards the Samovar Hills.

Our march was directed towards a point, about 21 miles off, where the sharp ridge at the end of the Hitchcock chain comes down to the Malaspina.

H.R.H. intended to take to the Seward Glacier from that point, as far as the foot of Pinnacle Pass, and thence the track followed by

Mr. Russell in 1890 over Dome Pass, Agassiz, and up Newton Glacier, in order to attempt Mount St. Elias from the north-east ridge connecting it with Mount Newton and the Augusta range. Judging by the accounts of previous explorers, this route seemed to offer the best chance of success, and by following it, Russell had approached much nearer to success than any other assailant of the peak. All explorers agree in describing the southern flanks of St. Elias as extremely steep, and swept by so many avalanches as to appear inaccessible. The ice plateaux at their feet are barely more than 2,000 to 3,000 feet above the sea, and it is doubtful whether the state of the mountain would allow of camps being pitched at a higher level. Yet without such camps it would be impossible to overcome the 15,000 feet up to the summit. But on the north-eastern flank there is the upper plateau of the Newton Glacier at 8,000 feet, and the remaining height of 10,000 may be divided by making a camp on the col.

Then, too, Mr. Russell had reported that this flank was neither excessively steep, nor apparently blocked by any impassable obstacle; that, in short, its only serious drawback would be the uncertain weather common to the whole region.

After three hours' march, once out of sight of the moraine, nothing but snow was visible. In front, behind, and to the left, stretched the vast white level, only bounded by mountains on the right. The prospect is very grand, but not at all picturesque; it lacks foreground, shows no contrast of colour, and the outlines are blunted by the thick snow-mantle covering every ridge and peak; while the sun, already high above the horizon, casts no shadows to break the uniformity of the view and throw it into relief. We are dazzled by the reflection of the snow, and have all put on our spectacles.

Dragging sledges is tiring work; for although the snow is in fairly good condition, they sink too deep into it. Accordingly, the men are often obliged to lift the prows in order to get them over the heaps of caked snow in front. Four men are harnessed two by two to each sledge ; the pair nearest the sledge have to keep it in the right track, and as far as possible in the tracks of the sledge ahead, where the beaten snow presents a harder surface. In dividing the labour, the men naturally fall into groups according to their occupations and tastes. Thus we have one team of guides, one of students, a sailor team, and a mixed team composed of Major Ingraham, Botta, and two Americans. The guides go capitally; being accustomed to snow, they pull together in step. The Americans will,

PREPARING TO CROSS A GLACIER STREAM.

little by little, grow used to the novel task. We follow behind, helping to push the sledges and set them straight when required. At first, we march twenty minutes, and then rest for five, but our halts grow longer and more frequent as our fatigue increases.

The surface of the glacier is undulating, and lies in long, wide furrows of monotonous, stainless white; the general inclination is very gentle, but by no means unfelt by the teams, and whenever we come to a steeper bit, the sledges are sent on one by one with eight men attached. Little ponds or puddles of slush lie at the bottom of almost every hollow; and at some points our path is cut by torrents of crystal-clear water dashing over ice-beds between sheer walls of snow. Fortunately we encounter few of these torrents, and as they are not wide, we get the sledges safely over them on improvised bridges of alpenstocks and axes. The layer of snow on the glacier is of different depths, from a span to a yard and a half; but the ice is nowhere uncovered, and no stones are seen.

As the day advances, the snow gets rapidly worse, and the

CROSSING A GLACIER STREAM.

work of dragging the sledges becomes so heavy that prudence compels us to stop in order to avoid over-fatiguing the men on the first day.

It was 8 o'clock a.m., and we had taken about five hours to cover six miles. So we pitched our camp on the ice, and after a hasty meal, sought refuge from the glaring light, which was burning our faces, inside the tents, where the soft, greenish reflection filtered through the flaps rested our eyes after the pitiless reverberation without. Foreseeing that mists might come on the next day, H.R.H., with one of our party, set off in the afternoon, to map out a track over the snow in the direction of the Hitchcock range.

As the sun declined, and its rays became more slanting, the landscape was transformed. Spreading shadows on all sides revealed the noble lines of cliff and valley, while ample rounded flutings of whitened crests and wide, soft undulations of snow-filled ravines contrasted with precipitous rock-walls, and the steep, hard, sharply notched ridges, where, here and there, the mountain rock pierced through. The monotonous milk-white shroud covering the land at mid-day blends with the sky towards evening in a delicate harmony of tints that pleases the eye, and gives almost

ENCAMPMENT ON THE MALASPINA.

an impression of reviving life to this world of perpetual ice. On the extreme edge of the horizon, where glacier and sky seem to meet, you discern a tremulous movement, as of a distant sea with a bluish vapour floating over it. This is really an optical effect proceeding from the radiation of the earth. Then, the whole glacier is flooded with a rosy glow, rather darker than that on the mountains. In the west, the great yellow disk of the sun sheds streams of yellow rays over the level, and all the snow-waste seems on fire.

The mild weather we were enjoying was too unusual to last in this region, and by midnight—the hour fixed for our awakening—it was raining in torrents. When the rain ceased about 3 a.m., we struck camp, wrapped about by so dense a mist that in half an hour we were dripping wet. By 5 a.m. we were on the march, and surprised to find the snow pretty firm.

For the first hour and a half we followed the track marked out by H.R.H. on the preceding day, but it soon became necessary to steer by the compass. We presently arranged our train so as to proceed in a perfectly straight line. A caravan of three persons, roped together, took the lead; for in that thick fog, and with so much snow on the glacier, hiding possible *crevasses*, it might have been unsafe for the vanguard to move over unknown ground without the rope.

A HALT ON THE MALASPINA.

The Prince took the hindmost place on the rope and steered by the compass, keeping the line of march north by north-west. About 150 feet in the rear of the first party, and therefore hardly able to see it through the mist, came a second group of us, charged with the duty of avoiding any slight deviation from the straight line produced in correcting the course. The sledges followed last. This long procession, and the indistinct forms of the men drawing the sledges, made a fantastic picture as of a polar expedition. Earth, air, and mist are all confused in the infinite desolation surrounding us on all sides. The pale, diffused light prevents our seeing clearly through our spectacles, yet we cannot take them off without being painfully dazzled by the reflection of the snow. The sledges go better than yesterday; their loads are more equally distributed, and the men are learning how to walk on snow. The glacier has no undulations here, and its surface is almost even, with so slight an upward inclination that we scarcely notice the ascent.

After marching four hours we halt near a torrent, in the rain, to snatch a hasty breakfast; and then go on till nearly 1 o'clock p.m.

In a little over six hours we had done seven miles. All round the camp the snow is darkened by myriads of small black worms, which swarm to the surface on misty days, but disappear when the sun comes out.[1] Mixed with these are innumerable tiny insects, which are hopping about in the liveliest manner, but bury themselves under the icicles whenever a hand is extended towards them. They are *Isotoma Besselsi Packard* or a near variety. Here and there a fly, lost in the mist or driven by the wind, lies frozen on the snow, and becomes the prey of the spiders, lurking in wait in every little hollow of the surface. Humble as they are, these manifestations of life show a marvellous adaptability to conditions apparently incompatible with their existence.

The next morning a slight lifting of the weather enabled us to ascertain that we were much nearer to our goal, and had taken the right direction. Starting at 5.30 a.m., we were soon enveloped in mist again. During the first hour or so, we marched in a straight line, but were then compelled to frequently diverge from it, in order to turn broad, conical depressions, that at first sight through the mist we took for wide *crevasses.* It was only on our return, in clear weather, that we ascertained their nature and size.

Before long the rain came down again, and the soaked snow clung heavily to our shoes and caked on the sledge-runners, greatly increasing every one's fatigue. Nevertheless, we made good progress with a ten minutes' rest after twenty minutes' march, and rejoicing in the hope of reaching the Hitchcock range that day. The drizzle continued in the afternoon, but the mists lifted enough to allow us a confused glimpse of the eastern extremity of the ice-fall terminating the Seward Glacier, and the spur of Hitchcock to which we were bound. At 3 o'clock we could discern a dark line of

[1] *Vide* Prof. Carlo Emery, Appendix D, for an account of these worms and of the few zoological specimens collected by the expedition.

detritus at the base of the hills, formed by strips of naked moraine, and half an hour later we were in the snow-filled hollow between the glacier and the chain. The passage of the Malaspina was accomplished.

All about us, isolated moraine heaps protruded from the snow, and under foot was such a deep bed of slush, mixed with sharp stones, that we sank in knee-deep, and there was no possibility of pitching our tents on it. The Hitchcock Hills are very steep on this side, covered with grass and low scrub, excepting where the slopes are

CAMP AT THE BASE OF THE HITCHCOCK RANGE.

seamed by slides of crumbled earth and grit. A covey of white partridge rose from the thicket at our approach, but perched on neighbouring bushes as though moved to more curiosity than alarm.

This last stage had covered about eight miles. The men were exhausted, and the rain had soaked us all. The guides and porters being unprovided with bedsteads, planted their tents on a narrow grassy ledge of the hills a short distance above the glacier, but ours were pitched on the snow. Our camp stood under the south-east

wall of the Hitchcock range, a few hundred yards from the Seward cascade, and 1,703 feet above the sea. This is the highest elevation of the east lobe of the Malaspina Glacier, which descends from this point to the Pacific Ocean and Yakutat Bay.

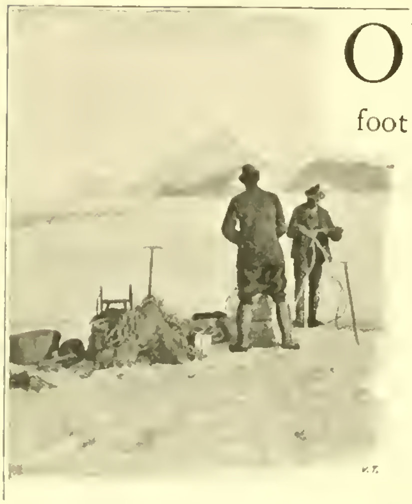
The following day, 4th July, was the anniversary of the Declaration of Independence of the United States. H.R.H. allowed the Americans a holiday for its celebration; and we saw their national flag flying over their camp up the mountain side.

In the nomadic life we were leading, it seemed quite natural to baptize every halting-place and every stage of our journey with names commemorating some incident of travel or local characteristic. Accordingly, our quarters by the spur of the Hitchcock chain bore the designation of "Independence" Camp.

A PARTRIDGE OF THE HITCHCOCK HILLS.

CHAPTER VI

Seward Glacier, Dome Pass, and Agassiz Glacier



OUR journey across the Malaspina plateau had brought us to the very foot of the mountains, and we were now to push our way through them by the Seward Glacier, which pierces the chains like a wide high-road, dividing the groups of Mount Cook and Mount St. Elias.

The Seward is the greatest known glacier of the Alpine type, and of much vaster proportions than the giant ice-streams of the Himalayas, which, until lately, were supposed to be unrivalled. It is more than 40 miles in length, from 3 to 6 miles in breadth, and flows majestically down at a very slight inclination, except here and there where the level of its bed makes a sudden dip, and the ice is split into a chaos of huge, irregular blocks. The Seward takes its origin from a wide basin, about 5,000 feet above the sea, lying between the Logan and Augusta chains, and bounded to the east by the Irving range, and the vast semicircle of mountains dividing the latter from Mount Owen. It flows from this basin in a southerly direction, first walled in by the Corwin Cliffs and the northern branch of the Cook chain; lower down by Mounts Augusta and Cook, then between the Samovar and Hitchcock Hills, and finally expands into the eastern lobe of the Malaspina Glacier, of which it is the principal tributary.

The valley through which the Seward flows presents three narrow gorges dividing from one another three vast amphitheatres of mountains, each enclosing a nearly level plain of ice. Thus the glacier forms three plateaux rising in succession like steps, and connected by ice-falls in the gorges. The first ice-fall is at the brink of the upper basin, at the northern extremity of the Corwin Cliffs; the second occurs where the two boundary bulwarks of the Pinnacle Pass—*i.e.*, the northern bastion of the Cook group and the southern wall of the Hitchcock chain—project into the valley. Below this point the glacier, which now becomes divided into countless blocks by a labyrinth of broad *crevasses*, presently spreads out between the Samovar and Hitchcock Hills, until the southern ends of these ranges converge, thus forming the third gorge through which the ice pushes down to the Malaspina in the final cascade.

Hence, the first difficulty before us was to conquer this terminal ice-fall of the Seward. On the 4th of July, the day after we encamped under the Hitchcock Cliffs, while the Americans higher up were celebrating the anniversary of Independence in this remote district of their fatherland, Gonella and Sella set off with two guides to explore the route. Fortunately the rain had ceased, although the sky was still clouded. We who remained in camp found plenty of work in spreading out clothes to dry, after the last two days' soaking, and arranging various things which had been neglected during our forced marches.

The Hitchcock Hills end in an abrupt spur some 450 feet high, and this being separated by a depression from the principal chain, has almost the air of an independent height. Gonella and Sella made straight for a deep ravine which ran up to this gorge, hoping to find a short cut through it to the Seward valley. But they encountered an unexpected obstacle in the shape of a small lake some 300 feet wide, and covered with floating ice, just at the bottom of the *couloir* between the edge of the Malaspina and the hills, analogous in formation to the lakes already described at the sides and southern end of the Chaix range. All these tarns are created in the same way. Wherever the edge of a glacier, without the protection of a thick layer of moraine, touches the rock, a depression is produced on the surface by the radiation of heat from the rocks and soil that accelerates the melting of the ice. The glacier naturally drains into the cavity thus formed, giving rise to a little torrent, which hastens the melting of the ice over which it runs. Where a steep spur projects into the ice-field (as the Hitchcock and Chaix Hills project into the Malaspina), the drainage-channels of the two faces converge and often unite at the extremity, forming a lake, which again generally discharges into an ice-tunnel.

The exploring party tried to reach the mountain side by skirting this lake, and finally reached it after no little trouble and risk of accidents from the numerous water-holes in the marginal ice. They then reached the *couloir*, and mounting by it to the depression in the ridge, soon found themselves at the edge of the Seward, on the plateau above the terminal ice-fall. They then followed the glacier downwards, in the direction of the ice-fall, and climbed the isolated point at the extremity of the Hitchcock Hills, hoping to discover some easier and safer route than the one they had just traversed, so that the whole caravan with the loads might reach the plateau without risk. This hope was realized, for in the angle between the ice-fall and the extremity of the mountain they descried a steep gully filled with snow, running up for about 300 feet, and which, notwithstanding a steep gradient, could be converted into a safe track, even for portage, by cutting a zig-zag course with the axe.

On the morning of the 5th July the guides went on ahead to do this work, while we broke up the camp. And now for the first time our caravan was divided. Five Americans were sent back with a sledge to fetch eight days' rations from the stores left on the moraine. In the three other sledges we carried all our things to the foot of the gully, making our way round the Hitchcock spur

ST ELIAS FROM THE FOOT OF PINNACLE GLACIER

among the sharp-edged boulders and stones of the left Seward moraine. This Seward moraine is composed of a strip of detritus, about 1,500 feet in breadth, running down several miles into the Malaspina Glacier. But now, early in July, it was still almost entirely covered with snow, save for a small space near the hills.

The porters slowly climbed the narrow wedge of snow beside the ice-fall, on the track cut by the guides. They soon got used to the steepness, but refrained from imitating the guides in their glissades down the slope to bring up fresh loads. Caution was advisable, for the scattered stones and open *crevasses* at the foot of the gully would have rendered a fall dangerous. By half-past 11 o'clock all the baggage was stacked on the Seward plateau, above the terminal ice-fall.[1]

COULOIR LEADING UP TO THE SEWARD.

On the plateau we were in the midst of novel scenery, entirely different from that of the Malaspina. Instead of the vast monotonous plain stretching to the horizon, unbroken by a single detail of line or colour, we now had before us a mass of ice some five miles wide, thrown up, as

[1] This track was never used again, either by the porters with fresh relays or by ourselves on the descent. Some days after we had climbed it, the lake at the foot of the Hitchcock became empty, and thus the caravans were able to cross its bed and mount straight to the hollow above without skirting the mountain spur. Lake Caetani and the Chaix Hills' lakes are subject to similar changes. They naturally overflow when the tunnels into which they discharge are blocked by masses of ice or detritus, and drain off when the tunnels are free.

by some violent convulsion of nature, into myriads of great blocks piled in the wildest confusion, like an ocean suddenly congealed during a storm, though lacking the symmetry of waves.

We were on a snow-drift heaped in a bend of the Hitchcock range, flanking the glacier. A mile or so beyond this point a cliff of the Hitchcock approached the glacier so closely as almost to come in contact with the *séracs*. We had no choice as to the route; our only course lay over the snow, round the base of the cliff.

THE SEWARD SÉRACS—MOUNT AUGUSTA AND MOUNT MALASPINA.

It was clearly impossible to take to the glacier, since it was seamed with *crevasses* in every direction. Equally impossible would it have been to cross to the other side. We must skirt the left margin, hugging the base of the Hitchcock's western flank, until we reach some point where a crossing can be effected. Fortunately the numerous *nevés* and glaciers from that mountain had massed together at its base, forming an almost uninterrupted dyke along the brink of the Seward. Following this route, we were able to convey the loads by sledge for considerable distances. But at many points it was necessary to carry everything on our backs, in order to climb steep drifts or cross rocky spurs which barred the road.

From this face of the Hitchcock range project two main spurs, each ending in a bifurcation enclosing a small *nevé* in its curve. The recess between the two great promontories forms a circular basin filled with level ice, which we named the Hitchcock Glacier.

CAMP ON HITCHCOCK GLACIER, CLOSE TO THE SEWARD—THE TOP OF MOUNT ST. ELIAS SEEN THROUGH THE CLOUDS.

It is dominated to the north by two sharp twin-peaks, one of bare rock, the other snow-clad, whose northern flanks fall sheer to Pinnacle Glacier. These are the two highest peaks of the Hitchcock group.

It was easy enough to get round the first spur through the snow at its base without unloading the sledges more than twice. We next crossed the Hitchcock Glacier, still skirting the jagged *séracs* of the Seward, as far as the foot of the second great spur. This is much loftier than the first, and juts out to the very edge of the Seward. It forms the southern wall of the Pinnacle Glacier, which, uniting with the Seward lower down, shoots over the ridge of this wall in an ice-fall. At one time traversing obliquely the steep bank of sliding soil, at another moment passing through snow-filled gullies, or climbing the ridges at their sides, we finally surmounted the second buttress; and at midday, on the 8th of July, camp was pitched at 2,979 feet above the sea, in the extreme south-west corner of the glacier that comes down from Pinnacle Pass.

It had taken four days to reach this point from the Malaspina. We had established a camp at the foot of the first buttress, and another, close to the second, on the Hitchcock Glacier. Excepting for a few hours, the weather had been almost constantly fine. The sun, even when partially veiled by mist, was excessively hot upon the glacier, and the light so dazzling that our eyes suffered in spite of smoked spectacles.

H.R.H. always left camp with a small party several hours in advance of the rest of the caravan, in order to prospect the way ahead, and daily pushed on to the farthest possible point. The loaded sledges followed slowly in the rear, and by evening we were all together in camp. The day we reached Pinnacle Glacier, H.R.H. pushed on to explore the route over the Seward, and following it almost to the mouth of the valley running down from Dome Pass, only returned to camp very late in the afternoon. He had ascertained that we must continue to skirt the edge of the Seward for two or three miles, before finding a practicable way across.

Only the guides were with us now. Ingraham and his five remaining porters had gone down with a sledge to meet the first party coming back from the Malaspina moraine. The latter were to join us farther up with fresh supplies, while Ingraham's party took its turn in going down to the depôt on the moraine. From this time on we only saw the porters occasionally and for brief periods. They were so prompt in following out H.R.H.'s plans, and executed his orders with so much punctuality, in spite of

SUMMIT OF [illegible]ARD GLACIER

unforeseen obstacles from bad weather and changed condition of the mountain, that we were never once delayed by having to wait for them.

Our camp was pitched on a tongue of the Pinnacle Glacier[1] that runs southward and crosses the end of a spur of the Hitchcock Hills, to unite with the Seward in an ice-fall. All the rest of the glacier is one great unbroken level, which joins the Seward with a wide frontage, and rises gently eastwards to Pinnacle Pass.

ICE-CASCADE AT THE JUNCTION OF PINNACLE WITH THE SEWARD GLACIERS.

Behind the pass we again caught sight of the snowy summit of Mount Cook. Beyond the level before us rose the vertical wall belonging to the Cook system, that forms the northern rampart of Pinnacle Pass. This wall is composed of distinct horizontal strata of black and grey rock and surmounted by the sharp, slender pinnacles to which the *col* owes its name. This bastion hid from our view the upper portion of the Seward. It stretches so far to the west that the valley is barely three miles wide at

[1] *Vide* the panoramic view of the Seward basin, at the end of the volume.

this point. Nevertheless, the glacier does not form an ice-fall here, there being no sudden drop in the level of its bed, but flows in a steep incline until it has passed the mouth of the Pinnacle valley, to the upper spur of the Hitchcock range.

There is a deep calm in these luminous afternoons. The glacier is alive with the murmur of running water in the *crevasses*, and the sharp repercussion of stones falling from the *séracs*. You can hear the stir of hidden vitality, the process of slow, continuous

PINNACLE GLACIER, MOUNT COOK.

change, although nothing is visible to the eye but the great frozen mass, betraying no sign of the giant force with which these millions of tons of ice press slowly forward. The whole glacier is covered with snow; only at the edges, *séracs*, soiled with detritus, form a darker line indicative of marginal moraine. These lines were much more distinct a month later, on our way back from Mount St. Elias.

The whole Hitchcock chain stretches in a wide crescent flanking the Seward, and we can trace the route followed during the previous days along the base of the cliffs. The farther side the glacier is bounded by the Samovar Hills, a low chain of rounded, stumpy heights covered with snow-fields, and broken by low ridges dividing vales filled by small glaciers. A crag of black rock, apparently separated from the main chain by a level tract of ice, juts into the Seward exactly facing the north bastion of Pinnacle Pass, and helps to narrow the valley at this point. It also masks a considerable glacier running up to the Dome Pass.

NORTH BUTTRESS OF PINNACLE GLACIER.

Behind the southern extremity of the Samovar chain, walling in the terminal cascade of the Seward, we perceive the outlines of other crests of the same group, little parallel ridges projecting towards the Malaspina. A large moraine produced by the fusion of the marginal moraines of Seward and Agassiz starts from these bastions and trails down into the Malaspina, like a colossal ribbon, trending westwards as far as the eye can reach, and dividing the eastern from the middle lobe of the glacier. This moraine also is now coated with snow. Behind the extremity of the

Samovar we discern the mouth of the Agassiz Glacier with its terminal cascade, and, still farther back, the Chaix Hills slightly veiled in mist. The Malaspina, usually obscured by low banks of fog, is distinctly visible this evening in all its vast extent to the far horizon, where it ends in a pale blue line that resembles, but is not, the sea.

Behind the Samovar chain, there, to the west, towers the symmetrical pyramid of Mount St. Elias. How much closer have we approached it since the day we first beheld it, half shrouded in mist, from the deck of the *Bertha*! Here, the proportions of the landscape are on so vast a scale that our peak seems to have dwindled, for all its importance, and we hesitate to believe it can be as much as 18,000 feet in height. At the feet of the northern and southern extremities of the mountain, which we now see in profile, rise the peaks of Mount Huxley and Mount Newton; while exactly facing us is the short, steep south-east ridge that joins the south bastion of the Newton valley. The northern wall of this same valley consists of a lengthy chain extending eastwards from Mount Newton, first surmounted by a string of unnamed summits, and then by the three great peaks of Mounts Bering,[1]

MOUNT ST. ELIAS—SEWARD GLACIER BENEATH PINNACLE GLACIER.

[1] H.R.H. gave the name of Bering to a broad snow-summit due west of Mount Malaspina and of somewhat inferior height. Viewed from the Seward, the top has the appearance of a long ridge running up at the eastern end to a peak that is connected with Mount Malaspina by a wide col of ice. Russell mentions a peak called Jeannette between Mounts Newton and Malaspina, but I was unable to obtain exact indications as to its locality.

Malaspina, and Augusta. The last of these unites with the head of the Samovar range.[1]

Mount Augusta (almost 14,000 feet) is undoubtedly the most important peak of this group, and the only one of sufficient majesty to compete with Mount St. Elias. It is a bald, precipitous peak, seamed with deep ice *couloirs*, crested with terrific ridges and with overhanging glaciers which apparently cling to sheer walls of rock. This face of the mountain appears to be quite inac-

WEST FACE OF THE HITCHCOCK CHAIN AND LEFT FLANK OF THE SEWARD, FROM THE BASE OF PINNACLE GLACIER.

cessible; our guides look at it reflectively, and confess that it would be hard to find a path up it unswept by avalanches of stones and ice.

Beyond Mount Augusta the chain suddenly takes another direction, bends to the north-east, and, dipping down considerably, forms the Corwin Cliffs, which flank the Seward Glacier to the west.

[1] *Vide* note at page 118.

Ever-changing mists drift lazily along the glaciers, gather upon the summits, vanish behind the peaks, and again return to shroud them the next moment. The sky is mottled with broken, shapeless clouds, tinged with rose colour here and there, while in the west the great blurred, yellow sun sinking into the mists is perhaps the best part of the picture. Throughout the vast expanse before us, bare rocks and ice are all that meet the eye ; not a trace of life, not a patch of verdure to enliven

FLOWERING LUPINS, BELOW THE PINNACLE CASCADE.

the desolate majesty of the scene. The southern spur of the Chaix Hills and Blossom Island are the only spots in this mountain waste where trees are to be found. On the southern slopes of the Hitchcock Hills, thickets of dwarf shrubs are the only growth. Nevertheless, at a short distance from the camp, against the south bastion of the Pinnacle, close to the spires and turrets of the ice-fall, we discovered a little stretch of soil where the snow had just melted, already clad with a thick mantle of dark blue lupins, mingled with violets, anemones, saxifrages, and moss. We noticed a few black flies among the flowers, and some pretty little grey birds, of the size of sparrows, were flying about overhead. A very oasis of colour and fragrance in the midst of the lifeless waste of ice.

On the 9th of July we crossed the snout of Pinnacle Glacier. It is from $2\frac{1}{2}$ to 3 miles in width, almost flat, and covered by a thick bed of snow, seamed in little parallel grooves, with long,

FLOWER-COVERED SLOPE OF THE HITCHCOCK HILLS.

reddish stripes formed by masses of the microscopic weed (*Sphærella nivalis*)[1] that is common to glaciers in all parts of the world.

The Seward *séracs* cling so closely to the north buttress of

[1] There is a complete flora of snow and ice, consisting of many species of weeds and lichens, all of the most diminutive size. Wittrock (quoted by A. Heim in *Gletscherkunde*, Stuttgart, 1885, p. 411) describes forty species of the Snow Flora, ten of the Ice Flora, and five species common to both.

the pinnacle that we cannot skirt round its base. Fortunately, a small snow-saddle was found close to its final spur, to which we were able to climb by a convenient bank of snow. On the rock ridge near the camp we discovered a scrap of cloth, evidently torn from a tent, and a small pile of stones. These were the only traces of mankind encountered during the whole of our ascent, and were left by Russell in 1890, when he camped here for several days after crossing Pinnacle Pass.[1]

THE HITCHCOCK HILLS, FROM "RUSSELL CAMP."

Accordingly, we named this neck of snow Russell's Camp. The ridge just above it juts out in a sharp point, which Mr. Russell christened Point Glorious, to mark his admiration of the view it afforded over the Seward basin and the encircling mountains.

On the slope behind Point Glorious there is a great level amphitheatre bounded to the south by the Pinnacle Cliffs, to

[1] The narrow ridge of the Pinnacle Cliffs, on which we were encamped, is interesting geologically. In Appendix E, Sig. Vittorio Novarese, of the Royal Geological Office (Rome), has given an account of the mineralogical specimens collected by the expedition, together with a short, critical summary of Mr. Russell's works on the geology of the Mount St. Elias region.

ST. ELIAS FROM SEWARD GLACIER IN SUNSET

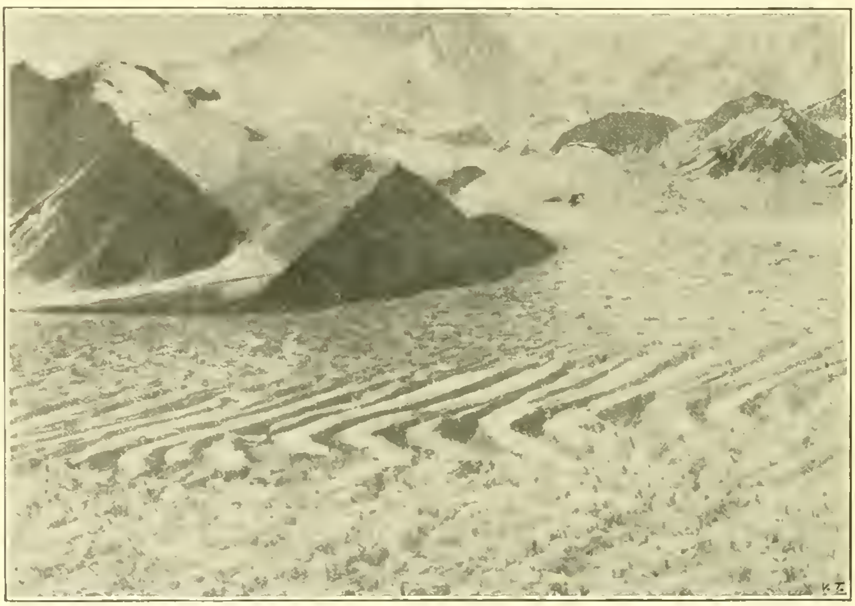
north and east by long slopes of snow rising to the flanks of the Mount Owen chain. In the distance, behind Mount Owen, we discern another gigantic snow-peak, Mount Irving, resembling Mount Cook, whose northern flanks drop down towards the upper basin of the Seward. This upper basin seems bounded to the north by a girdle of mountains mostly covered with snow and, probably, joining Mount Logan to the west.

Looking down on the Seward Glacier beneath us, we note

MOUNT OWEN, FROM POINT GLORIOUS.

that its *crevasses* are as regularly disposed as if planned on some colossal design. Immediately below the upper cascade, at the outlet of the original basin, the glacier forms a wide, gently-sloped expanse cut by numerous *crevasses*.

About a mile above Point Glorious the slope becomes steeper, while the glacier deviates from its former south-easterly course, and, making a slight bend, flows straight towards the south. The upper portion has only marginal *crevasses*, which run, as usual, obliquely from the lateral banks towards the centre of the glacier against the direction of the current, and branch off from the sides at an angle of about 40°.[1] The cracks proceeding from either margin of the glacier meet in the centre lower down, thus forming *crevasses* in the shape of an inverted letter V, across the entire width of the ice, with the apex in the centre and pointing upwards, the extremities at the sides and turning downwards. These *crevasses* occur at regular intervals about 50 feet apart. But their shape changes before long. Owing to the greater velocity of the current in the middle of the glacier, the vertex



SEWARD GLACIER (CENTRAL PORTION).

of the V flows down faster than the ends ; and the original angle of 50° to 60° becomes more and more obtuse, until every *crevasse* runs in a straight line all the way across. As the descent continues, the angle is gradually reversed : first the *crevasses* become crescent-shaped, with the cavity turned upwards ; then again take the form of a V, enclosing an angle of about 30°, with the apex downwards. Meanwhile, the cracks grow wider

[1] For complete explanation of this particular arrangement of *crevasses* the reader is referred to books treating of glacial phenomena.

and wider at the centre of the glacier, and the layers of ice dividing one from another are broken up by the constant pressure into short *crevasses* running in a perpendicular direction to the main ones, and parallel with the glacier's axis. Thus, at last, the whole mass is split up into gigantic cubes, most of which are completely isolated by fissures on every side.

Below the point where Pinnacle Glacier runs into the Seward, the *crevasses* are so numerous and so intricately interlaced that no fixed order of arrangement can be traced: nothing but irregular blocks of every size heaped up at random. And in this state the glacier continues down to its terminal cascade.

The aspect of the Seward was somewhat different in 1890, when Mr. Russell first saw and described it. At that time the transversal arrangement of the *crevasses* was maintained down to the lower portion of the glacier, and the surface became smoother for some distance before reaching the final cascade. Possibly, all the ice was more thickly covered with snow that year. Even the glacier's rate of descent must have decreased since 1890. Although Russell's attempts to measure it at the time failed to give conformable results, he maintains that the rate of speed in the centre of the glacier must be 20 feet daily, at the least. Mr. Russell and his fellow-explorer, Mr. Kerr, both relate how *séracs* frequently crashed down with such force as to shake the ice under their feet, and they add that almost incessant reports and rumblings were produced by the rolling and shattering of the fallen blocks. Nothing of the kind was observed by ourselves during the days we spent on and about the Seward. The glacier was always perfectly quiet; only now and then a solitary stone would come down, or a fragment of *sérac* would drop into a *crevasse* with a dull thud.

Seated on the rocky spur near the camp by Russell's stone cairn, we gaze with emotion upon the splendid spectacle before us. As usual, the evening light softens all the details. The faint haze clinging to the mountains lends a peculiar softness to their harsh ridges and to the dark shadows in the hollows. The glaciers of Hitchcock, of Seward, and of the distant Malaspina, are a warm creamy white ; the faintest trace of shadow just barely marks their broad undulations. Our caravan track runs like a furrow across the Pinnacle Glacier : the only break in its great level surface. Delicate mists wreath the highest peaks. The sun has set slowly behind Mount St. Elias, and its two crests, north and south, glow faintly, as if they were phosphorescent. One last ray gilds the summit of Mount Augusta, whose darkly shadowed slopes look black and sullen, in vivid contrast to the splendour around. Frost has arrested all movement ; no stone falls, there is no sound of water in the *crevasses* of the Seward. A dead calm prevails, an utter silence, a penetrating and serene sense of peace.

The following day (10th of July) we crossed the Seward. To find a route down to the glacier we had to coast again, for a while, round the edge of the spur on which we had camped, dragging the sledge over the snow-slope at its base. The weather was cloudy and oppressive ; the snow in a very bad state. The guides found it as much as they could do to manage a single sledge, while we assisted in pushing it over the steeper parts of the way, and supporting it with our shoulders to keep it from rolling downhill. After conquering a second spur, covered with broken ice, by dint of carrying all the baggage on our backs, we again reloaded the sledge, and finally struck out across the Seward in a westerly direction. The glacier is about three miles wide at this point, but we were obliged to take so tortuous a route in order to avoid the *crevasses* that the distance was nearly doubled, in spite of the preliminary exploration by H.R.H., which had reduced these inevitable deviations to the minimum.

We kept a course parallel with the huge *crevasses* along strips of ice scarcely wider than the sledge, and sometimes across square blocks connected by snow bridges, which were, fortunately, solid enough. A party of two, roped together, were in the van, carefully

A VANISHING VIEW OF ST. ELIAS FROM SEWARD GLACIER

testing and "sounding" with the ice-axe every bridge over which the heavily-laden sledge and its team of five men had to pass.

The transversal *crevasses* measured from 30 to 50 feet in width, and had a peculiarity that was quite new to us all. Their walls were not of ice but of granulated snow, arranged in strata 10 to 15 feet thick, separated one from the other by darker layers of dust and fine detritus. In the deeper fissures we counted from eighteen to twenty of these snow-strata; but in none, as far down as we could see, was there any of the green ice peculiar

TRAVERSING THE SEWARD.

to glaciers. Every one of these strata must be the result of a fall of snow, while the intermediate dark layers represent periods of fine weather.

As we drew nearer to the middle of the valley, the whole expanse of the amphitheatre north of the Pinnacle Cliffs, with Mount Cook in the background, unfolded itself to our eyes. So many tributary glaciers pour down into the Seward from all sides, that one scarcely understands how so enormous a volume of ice can possibly squeeze through the gorge between the Pinnacle Cliffs and Samovar Hills. The wall of Mount Augusta towered above us, but its base was hidden by a low sandstone buttress separating the Augusta Glacier from the Cascade Glacier.[1] The peak appears to be a regular cone of snow, the summit of which is lost in the clouds. On reaching the mouth of the valley coming down from the Dome Pass, we see beyond the latter, and above the Samovar ridge, the whole course of another great vale, closed on its western side by a wall of ice terminating in a *col* at the foot of the north ridge of Mount St. Elias. This is the Newton valley, and the remainder of our route lies mapped out before us. Then gradually, as we draw closer to the Samovar Hills, Mount St. Elias and Newton valley begin to sink behind them and finally vanish altogether.

MOUNT AUGUSTA, FROM THE SEWARD.

On reaching the point where the glacier flowing down from the Dome Pass unites with the Seward, we call a brief halt for lunch. After this, the guides go back to fetch the second sledge, while H.R.H. and the rest of us, dragging the one we have with us, push on a mile or so farther up the Dome Pass valley, and pitch camp at about 3,350 feet above the sea.

CAMP ON SEWARD GLACIER.

[1] *Vide* note on page 118.

Towards evening rain begins to fall, and continues the whole of the next day. The guides employ the time in bringing up the remainder of the baggage from Russell Camp, discarding at the base of Pinnacle Cliffs one of the two sledges we had retained. Thus there is now one sledge on the Malaspina, another on the snow-slopes of the Hitchcocks, and a third on the Seward. In this way the porters are spared the labour of carrying them on their backs across ice-falls and rocks.

CAMP ON THE SEWARD, AT THE FOOT OF DOME PASS: LOOKING EAST.

The glacier by which we have to mount from the Seward to the Dome Pass is not steep, and the few wide *crevasses* are spanned by solid snow-bridges. At the beginning of the ascent we have on the right the Cascade Glacier, which falls precipitously down from the south-east face of Mount Augusta through a deep gully; farther on, our course lies between sheer walls of the Samovar Hills, composed of rocks so homogeneous in structure that, in spite of continual avalanches of stones, no *couloirs* are formed. The little side gullies opening here and there are filled with snow.

Higher up, near the pass, the incline becomes somewhat steeper, and we have to skirt round a few yawning *crevasses.*

The Dome Pass (3,800 feet) is more than 300 feet above our last camp. Two glaciers flow down from it, one eastward into the Seward, the other westward into the Agassiz. The pass is flanked on either side by two symmetrical, smoothly-curved domes, that to the south-west crowned by a perfectly hemispherical ice-cap, the other to the north-east with a rocky top bordered by a snow cornice, soon to be melted by the sun. The cloudy weather, soon

CAMP AT THE FOOT OF DOME PASS, ON THE SEWARD: LOOKING WEST.

to change to fog and rain, prevents us from obtaining any view to the west of the *col* in the direction of the Agassiz Glacier.

On the day when we encamped on the Dome Pass, we were joined by Ingraham and the five Americans who had descended to the moraine from Independence Camp, meeting on their way the other five who were journeying back from Pinnacle Camp. In the space of one week these hardy Americans had done more than forty miles on the Malaspina Glacier (going and returning), and over twenty miles in addition by the difficult route along the base

MT COOK FROM SEWARD GLACIER

of the Hitchcock Hills and across the Seward, carrying baggage of about 600 lbs. weight, including their own provisions and equipment, together with eight days' rations for our own party. It was remarkable to see how rapidly the men became accustomed to carry on their backs or drag upon sledges increasingly heavy weights. The 45 to 50 lbs. per head that at first was considered a heavy burden on almost level paths became the ordinary load

DOME PASS.

for every porter, even on difficult tracks and steep inclines. As for the guides, each of them was now equal to carrying as much as 80 lbs. weight for a moderate distance.

The valley branching westward from the Dome Pass is longer than that to the east, and is still walled in by the Samovar Hills. The cliffs are of the same character as before. The glacier is only slightly *crevassed*, and terminates at the bottom in a drop, luckily not steep enough to form an ice-fall. We descend it easily, letting the sledge slide down on a wide ridge of ice between two deep furrows, and halt (13th July) on the eastern ridge of the Agassiz Glacier, at the foot of the *col*. We have descended about 485 feet, so are now a little lower than at the corresponding camp on the Seward, about 3,566 feet above the sea.

The Agassiz Glacier—its broken surface bristling with jagged *séracs*—skirts the base of the north buttress of the Dome Pass,

CAMP ON THE DOME PASS.

winding towards Mount Augusta and the Malaspina. Behind, there must be a great basin collecting the snows from the west flank of Mount Augusta, from the Malaspina and Behring, bounded by the Samovar chain on the east, and, on the west, by a ridge running down from the Behring and dividing the upper basin of the Agassiz from the lower part of the Newton.[1] Our camp stands

[1] Mr. Russell gives a somewhat different account of the topography of this region. In his opinion, the head of the Samovar chain, instead of joining on to Mount Augusta, is connected with Mount Malaspina, whence glaciers run down into the Seward (Cascade Glacier). From our own observations on the spot, and from

ON THE AGASSIZ GLACIER

facing the great cascade of *séracs* with which the Newton hurls itself down into the Agassiz, and at their point of junction the two glaciers are of about equal volume.

On the north buttress of the Dome Pass, rising steeply at a little distance from us, a few patches of green are still seen 600 feet higher up. The limit of vegetation on the mountain slopes

ON THE AGASSIZ, AFTER THE RAIN.

careful studies from the photos we brought back, the arrangement of the mountains would seem to accord with the description I have given above. That is to say, the Samovar chain would form a buttress of Mount Augusta (supposing this name to be applied to the highest and most imposing summit of the group), and all the glaciers on the southern walls of Mount Malaspina would flow into the upper basin of the Agassiz. The buttress coming down from Mount Behring, and bordering this basin to the west, is the same that, during the whole of our march up the Newton valley, hid from us the western flanks of Malaspina and Augusta, and is clearly seen in all the photographs of the region to the east of Newton Glacier which were taken in Newton valley, on the Russell col, and on the ridge of Mount St. Elias. We have retained the name of Cascade for the great glacier flowing from the south-east flank of Mount Augusta, situated between the head of the Samovar chain and a short buttress that divides it from the Augusta Glacier. It falls into the glacier that descends to the east of the Dome Pass, just before the latter is merged in the Seward.

facing south must be therefore at about the level of 4,000 feet above the sea. From the camp we can hear the note of partridges among scanty grass-tufts, as well as the whistle of an occasional marmot.

The spurs on the north of the Malaspina Glacier own a richer fauna than might be expected. On the Chaix Hills a good many bears, wolves, foxes, mountain goats, partridges, and a shrew-mouse have been found. A track well beaten by quadrupeds runs north-east from the base of the hills and across the Malaspina

CROSSING THE AGASSIZ GLACIER.

Glacier for seven or eight miles towards the Samovar chain (Russell). Even a fish was once found in a glacier torrent that pours into the Caetani Lake. The history of these zoological species would repay study. How and when did they come here, and from where? Imprisoned in a narrow zone, surrounded by glaciers on every side, in a region where the earth is frost-bound for at least seven months of the year, their existence seems almost miraculous.

Easterly and south-easterly winds were now blowing persistently, accompanied by rain, mist, and heavy cloud-banks, which hung motionless about a thousand feet overhead. During several days the sun only appeared at distant intervals for a short time, emitting a pale, colourless light that the reflection from the snow rendered fatiguing and bewildering. Infinite precautions had to be taken to keep the interior of our tents tolerably dry. But by this time we were almost damp-proof. The temperature remained quite bearable, being nearly always a little above freezing point, and two hours of misty sunshine sufficed to dry our belongings. The expectation of what was before us and of the probable hardships to be faced made us indifferent to petty inconveniences. Mindful of Russell's advice, Sella had adopted the plan of lowering a pail down a *crevasse* and obtaining water in this fashion. It was a happy idea, and led to much saving of fuel. Considerable heat is required to melt snow or ice, and as half a gallon of petroleum was the daily allowance for making early coffee, tea at other meals, and soup for all ten of us, it was best to be thrifty. Accordingly, we always tried to camp near a tarn, and sometimes patiently collected water from the drippings of a convenient *sérac* during the warm part of the day.

ICE-VAULT OVER A LAKELET ON THE AGASSIZ GLACIER.

We crossed the Agassiz on July 15th, re-ascending it obliquely towards the western extremity of the Newton ice-fall. The surface of the glacier is very unequal, and on the left half of it (to the east) every depression is filled by a small pool. Here and there we came upon torrents. As previously on the Malaspina, we got the sledge over these by bridging them with our ice-axes. The water of these lakes is clear as crystal, of dark cobalt blue in the centre, where it is deepest, and shading off to a fainter tint near the edge. Where snow-bridges occur across the tarns, the colour of the water is reflected on the snow in extremely delicate tones. We

CAMP AT THE FOOT OF NEWTON GLACIER.

encountered many wide *crevasses*, and sometimes strange *séracs* formed arches and viaducts over the blue water, often resembling the work of man.

At the end of our march the tents were pitched on the western side of the glacier, at 3,740 feet above the sea, beside a small pool canopied by a great, smoothly curved, overhanging *sérac*, resting on a pillar of ice.

We were now at the foot of a buttress which comes straight down from St. Elias, and after forming the south wall of Newton

IN NEWTON VALLEY - THE FOG GROWS THIN

valley Glacier, bends to the south-east at the latter's terminal cascade, and becomes the boundary of the Agassiz valley. From the camp we had only a view of the Newton terminal cascade, which is loftier and wider than any we had seen before, and with the flank of the Newton Augusta chain, covered with huge, precipitous glaciers, making most imposing of backgrounds.

H.R.H. had already explored a track to the Newton, up a narrow wedge of snow between the western brink of the cascade and the rock-cliff walling it in.

Having passed the last point where the sledge can be used, all the loads must henceforth be carried on our backs. We leave everything behind except clothes actually in wear, thus limiting our baggage to the barest necessaries of life.

Mr. Russell had adopted the same course, and practically at the same point, in 1891; accordingly, the present camp at the foot of the Newton Glacier retained for us the name he had formerly given it of "Sledge Camp."

CHAPTER VII

Newton Glacier

ON July 16th we struck our tents at Sledge Camp and set out to climb the Newton Glacier, dividing our party into several caravans, each of which started as soon as the loads were packed. We had spent one night only in this camp, and had worked very hard to get everything in readiness for the start. We were impatient to make our way up this last valley, from the top of which we expected to obtain a complete view of Mount St. Elias from base to summit.

The Agassiz Glacier pours down from its basin in a very broken state, and its surface becomes still more chaotic as it flows past the terminal cascade of the Newton. The two glaciers do not fuse at once in a single mass at their point of junction; for some distance the Newton *séracs* stand out from the surface of the Agassiz in the shape of huge blocks of hard snow, scattered between the *crevasses*, or half buried in them, now stretching across them like a bridge, or again poised on the very brink, often at so sharp an angle that one expects them to fall at any moment. To reach the foot of the ice-fall at the western end, we have to walk for a while over this rugged tangle of the Agassiz, threading labyrinths of ice-blocks and

cautiously crossing snow-bridges, over numerous *crevasses*, often half filled with water.

We gained the Newton plateau in the same way that we had mounted the terminal ice-fall of the Seward ; namely, by a tongue of snow and ice wedged between the rocks and *séracs*. This gully, however, is double the height of that on the Seward (about 600 feet), and is split half-way up by three or four wide *crevasses*, with edges of live ice, placed almost vertically one above the other. To cross these with our loads was an unpleasant bit of work, but neither difficult nor dangerous. The snow in the gully was studded with stones and boulders fallen from the perpendicular rock-wall 1,000 feet in height, which bounds it on the left, and is furrowed with innumerable vertical grooves, surmounted at the top by a glacier, of which the edge is visible.

TERMINAL CASCADE OF NEWTON GLACIER (SHOWING THE ROUTE TAKEN BY THE PARTY).

On reaching the top of this *couloir* we turned to the right towards the centre of the Newton Glacier.

The upper valley was filled with mist, and we could see nothing in front of us, excepting another huge fall of *séracs*, extending across the whole width of the glacier and apparently barricading the valley. In little more than half an hour we had traversed the plateau and cast off our loads almost at the foot of the second ice-fall, 14,485 feet above the sea.

The leading characteristic of all the great glaciers of this region—namely their division into terraces connected by ice-falls—is more obvious in the Newton than in any of the others. Here the foot of the terminal ice-fall is at 3,740 feet above the sea, while the basin from which it flows is at 8,661 feet. The difference of level is owing almost entirely to the three tremendous drops, between which

Mount Malaspina. Mount Augusta.

EASTERN VIEW FROM THE SECOND PLATEAU OF NEWTON GLACIER.

the glacier forms three plateaux. The lowest of these, just above the terminal cascade, is 745 feet higher than the Agassiz; the second terrace is 1,875 feet above the first, while the topmost is at a level of 2,201 feet above the second. Thus the ice-falls increase in height as the valley rises. The lowest, however, has the most precipitous drop, and the ice is so broken that it might perhaps be impossible to climb it in the centre; the second is less steep, and subdivided by a short stretch of comparatively level, though still

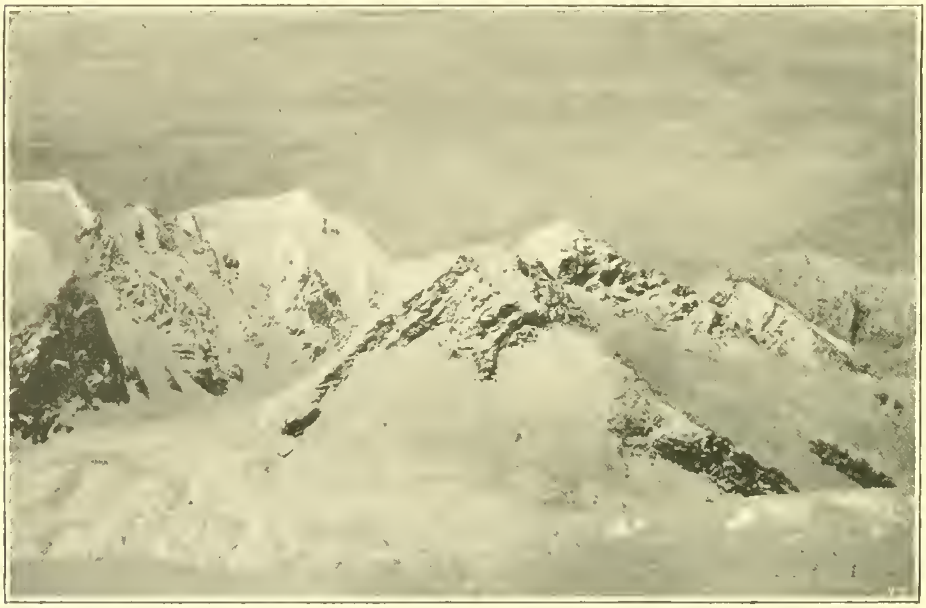
ON THE SERACS OF NEWTON GLACIER

broken ice.[1] The highest of the three is steeper and shorter than the middle one. The surface of the intermediate terraces is undulating and full of *crevasses*; but the uppermost of these is the widest and steepest. In fact, the two lower plateaux are almost level, and at certain points their slope is actually reversed.

The glacier runs through a deep valley, the head of which is closed by a steep ice-wall rising to the *col* between Mount St. Elias and Mount Newton. On either side it is bounded by two buttresses of Mount St. Elias, with a medium height of about 10,000 feet. Of these the one to the north is the more picturesque. To the blunt, flattened summit of Mount Newton succeeds a long series of slender pinnacles and dizzy ice-peaks, reaching heights of 12,000 to 13,000 feet, and connected by sharp ridges, variously twisted and curved, falling at every angle on all sides, and edged with huge cornices of snow. The chain extends as far as Mount Behring, keeping the same height throughout its length. A short ridge juts out from the latter summit, and, barring the base of the valley, compels the Newton Glacier, running from west to east, to change its direction during the last part of its course towards the Agassiz, so that its terminal cascade faces due south. The southern buttress of the valley, starting from the eastern crest of Mount St. Elias, forms two fine peaks—one of ice, the other of rock; then running down to the mouth of the vale, makes a turn to the south-west, and forms the western wall of the Agassiz Glacier. This mountain barrier separates the Newton and Agassiz from the Libbey Glacier, which pours down into the Malaspina from the south-east flank of St. Elias. Both sides of the valley throughout its length are precipitous and deeply covered with snow; even where the cliffs are vertical or overhanging the frequent snow-falls leave them sprinkled with white patches. Numerous glaciers, piled into *séracs*, cling to the steep rocks, as though suspended over the valley, and some

[1] Owing to this division, Russell considers that there are two cascades between the lower and the middle terrace, and consequently that the Newton Glaciers form four cascades.

end suddenly in a vertical white wall at the edge of the precipice. Of the many peaks crowning the valley, not one seems accessible from it ; throughout this vast range of mountains one looks in vain for some point of vantage whence a reasonably secure route to the top may be descried. The sole exception is the short extent of cliff that bars the head of the valley and leads to the base of the northern ridge of Mount St. Elias, although at too great a distance for us to decide as to its safety from avalanches.



NORTH SIDE OF THE VALLEY, FROM THE SECOND PLATEAU OF NEWTON GLACIER.

The Newton Glacier is about eight miles in length. It took us thirteen days to reach the upper end. We encamped six times on the way, and our average march was a little over a mile and a half. We had to contend almost constantly with persistent and dense snow-falls, which lasted entire days, enveloping us in a blinding cloud that made our surroundings strangely vague. It was heavy walking through the powdery snow, in which we often sank to our hips, while we had to grope our way patiently among the great blocks of ice, over snow-bridges, often insecure, and amid the incessant roar of avalanches and stone-falls which thundered down from morning till night on the margins of the glacier.

The Newton was no less inhospitable to us than it had been to our predecessor, Russell, for we had only three fine days out of the thirteen. It is hard to say whether these interminable snow-falls are owing to the general climatic conditions of the region or to local characteristics related with the direction of the valley, its altitude, etc. Mr. Russell maintains that there is more bad weather on the summits than on the frozen plateaux at the base of the chains. Mr. Topham, on the other hand, asserts that there is often a whole day of rain on the sea-shore when the sky is perfectly clear over the peak of Mount St. Elias. We ourselves observed that the sky always cleared first round the summits, and we found less fresh snow on the *col* and crest of Mount St. Elias than down in the valley. We also frequently noticed heavy fogs entirely covering the levels of the Malaspina Glacier and its banks when all the high valleys were in sunshine under a clear sky; while a comparison of the meteorological observations taken by Mr. Hendriksen, the missionary at Yakutat,[1] with those taken simultaneously by ourselves on the mountain, shows that there is more mist and cloud at low than at high levels.

In spite of persistent bad weather, our days on the Newton Glacier were neither monotonous nor wearisome. The scenery revealed such wealth of colour and form, that every day, in all sorts of weather, some novelty was seen, some endless succession of unexpected views. The glacier is usually blue—and of deeper blue in mist than in sunshine—not greenish, as on Alpine ice-fields. This colouring pervades the air, and is caught and reflected by the mist, until everything is bathed in a transparent azure. The effect is so constant and so marked, although in varying degrees of intensity, that this might appropriately be named the Blue Valley.

Probably the tint is owed to the enormous quantity of snow that covers the ice everywhere, even in the deepest *crevasses*. During

[1] *Vide* Lieutenant Cagni's meteorological notes in Appendix B.

our first evening on the Newton, we saw a strange and beautiful spectacle. About 6.30 p.m. the dense fogs which had masked the valley all day lifted a little, clearing away from the glacier and its precipitous rock-walls, and all the head of the valley appeared of such a deep indigo tint, that it was impossible to distinguish which was ice, sky, or rock. Little by little this colour spread, growing gradually fainter and fainter, and tinging with blue, one after another, every ice-

EAST BUTTRESS OF MOUNT ST. ELIAS.

fall and *sérac* of the Newton, and the mountains on either hand, with their glaciers, until everything was bathed in an azure haze.

The portage of all our belongings, from the Agassiz up to the Newton, was only completed on the following day (17th July). An icy cold rain, mixed with sleet, was pouring down. The guides had returned to Sledge Camp to fetch the baggage left behind there the previous day. H.R.H. and Lieutenant Cagni had gone to fetch a few loads which had been brought up to the top of the ice-fall, and deposited on the snow. Two hours later, on their return to camp,

great excitement was caused by the news that they had sighted four men climbing the Agassiz Glacier in the direction of the last camp, where our guides still remained. Evidently the strangers must be a portion of Mr. Bryant's caravan. More than once we had felt surprise at finding no trace of the expedition that was supposed to be in advance of us, and had divined, what was really the fact, that it had ascended the Agassiz instead of the Seward Glacier, following the route taken by Mr. Russell in 1891. At about 6 o'clock p.m., during a downpour of rain, our guides appeared at last with a letter from Mr. Bryant. The progress of his caravan had been much delayed by the illness of one of the porters, and the consequent loss of his services and those of the comrade detailed to look after him. After climbing the Agassiz to within a mile or two of the Newton ice-fall, Mr. Bryant had decided to abandon the ascent. Having descried two tents left at the foot of the fall, he had gone up there to inform H.R.H. or some member of his party that he withdrew from the attempt on Mount St. Elias, and wished him every success. After giving this letter to our men and taking a short rest, Mr. Bryant started down the glacier with his party. We had missed, by a few hours, our one chance of meeting the only other men besides ourselves on the vast icy desert.

The lower plateau of the Newton was the last place where we had rain; higher up it was always snow. Accordingly, the limit of rainfalls in the St. Elias region may be assigned to the altitude of 4,400 to 4,500 feet.

The remaining portion of the plateau to be crossed before reaching the second ice-fall is seamed with huge furrows, and has several little tarns; before long, the glacier slopes upwards more steeply, and beyond some wide *crevasses*, we come to the *séracs* of this second cascade. Whether from special atmospheric conditions, or from the greater extent of snow-field, those optical illusions which are common to all glaciers were manifested on a most unusual scale. We found ourselves climbing in and out of troughs of varying depths between rugged ice-waves, almost without visual perception of them. In fact, we only realized their existence by periodically losing sight of the party ahead, or when, on turning to look back, we found our view of the glacier was shut out by some incline we had descended unawares.

The first half of the ice-fall is easy to climb. In some parts of it, the *séracs* lie in rows, divided by wide furrows, which form a direct and easy path between snow-walls rising to about

SMALL LAKE, AMONG THE NEWTON SÉRACS.

thirty-five feet. But the numerous *crevasses* compelled us to perform more gymnastic exercises than were desirable with our heavy loads. At last, however, we emerged from one of these icy corridors on to the comparatively flat stretch of ice, that divides the second cascade into two parts. It is seamed by numerous torrents flowing between high banks of snow, and scattered with round masses of ice, among which lurk limpid pools of blue water. H.R.H. decided to encamp on the margin of one of these lake-

lets, in a hollow sheltered by snow-slopes. Our march had taken two hours and a half.

A drizzle of sleet went on the whole of the 18th July; but the 19th being a splendid day, we took advantage of it to carry up our baggage as far as the lake. In the evening, Ingraham and five porters appeared with fresh supplies, so H.R.H. detained them to give us their assistance in moving our camp farther on. Excited by the view of Mount St. Elias, now apparently very near, and anxious about the uncertain weather, we decided to lighten our loads by leaving the iron bedsteads behind.

MOUNT ST. ELIAS, FROM THE SECOND CASCADE OF NEWTON GLACIER.

We started all together the next morning, under a clouded sky and in oppressively sultry weather. We were soon among the *séracs*, and our route became very picturesque; but unluckily the varied details of the scene proved so many hindrances to our progress. We were always either clambering up or scrambling down, or squeezing through chilly ice passages, in the depths of narrow *crevasses*, where there was barely room for our loads, under dripping snow-cornices. In the faint, glimmering light we could just discern cavernous vaults, enclosing blue pools of half-frozen water. Beyond these passages, the view was bounded on all sides by thousands of white-crested *séracs*, forming so tangled a labyrinth that it seemed impossible to find a way through it. Before long, the fog closed about us more densely, and a shout from the front warned us that it was useless to try to thread all these intricacies in a blinding mist, and we were thus obliged to halt half-way up the ice-fall, on the scanty level of a *sérac*, barely affording room for our tents. The Americans soon started off on their return-journey; while after a hasty meal, we sought refuge under the hospitable canvas to escape from the unspeakable melancholy of this waste of ice shrouded in cold grey wet mist.

For three whole days we were detained in this camp, in the

THE CAMP AFTER A SNOW-STORM.

most obstinately bad weather it is possible to conceive. The resolutely hostile mountain was meeting its invaders in a manner worthy of its fame. Snow began to fall heavily on the night of our arrival, and on leaving our tents early the next morning (21st July), we found that the drifts had completely buried stoves, utensils, instruments, and numerous miscellaneous objects, left out on the previous evening. After a long and patient search, we succeeded in recovering all our belongings, and carefully gathered them together to avoid losses which might entail serious inconvenience.

The appearance of our camp was now entirely changed. The sides of the tents had caved in under the weight of the snow, the very pegs were capped with big white heaps, and even the ropes were covered with a thick layer of frost. Notwithstanding the waterproof qualities claimed for our canvas roofs, the water was dripping through inside, and we had to clear off the snow and tighten the ropes, to try and put a stop to this very inconvenient leakage. Armed with axes and cooking utensils, we set to work to dig trenches round the tents, and get rid of the accumulated snow. But it was falling so fast and so thickly, that almost incessant labour

CAMP ON NEWTON GLACIER, IN THE FOG.

was needed to prevent everything from being buried. In a very short time there was a bank three feet high round the tents.

Through the faintly rose-tinted mist one could discern on all sides the vague outlines of piled *séracs*, bowed down, as it were, by their heavy load; while around the camp the ice sloped steeply downwards to invisible depths. Steadily, ceaselessly, the noiseless white flakes fell. From time to time the roar of an avalanche broke the oppressive silence. A flight of stray birds, doomed perhaps to perish of exhaustion on the ice, fluttered through the mist, and for a moment turned our thoughts to green woodlands and the stir of life.

Fortunately, bad weather in Alaska is usually calm weather. Snow and rain are seldom accompanied by storms of wind. We never saw, either in the horizon or about the peaks, the dark, rounded thunder-clouds which mean storms,[1] nor even a single flash of lightning. All night and throughout the following day the snow-

MOUNT NEWTON AND THE THIRD CASCADE OF THE GLACIER.

fall continued. Only towards evening, on the 23rd of July, had we a few hours' respite. The thick fog-curtain lifted gradually here and there; first, the near *séracs* emerged, then peaks appeared for a moment, soon to be hidden again behind drifting mists, while now and then blue sky showed between the clouds. There were continual, fleeting glimpses of mountain crests, lighted by an increasingly clear

[1] Mr. Russell had a different experience. At the end of August, 1891, near the coast, he was assailed by such violent hurricanes that he was driven to seek refuge in the forest, all progress being impossible on the open moraine.

and brilliant radiance, a succession of pictures appearing and disappearing as the mists floated this way or that, until at last the whole valley lay revealed. The layers of mist, dividing *séracs*, cliffs, and crests into a series of terraces one above the other, added to the grandeur of the scene. Delicate mist-wreaths clung to the higher rocks, torn into fringes, and driven hither and thither by the breeze. All around us were ridges of ice, and the infinitely various and grotesque humps formed by the *séracs*, laden with fresh snow. The fleecy burden softens every curve, and rounds every angle and edge of the fissures, so that these Alaskan *séracs* have a very different aspect from those of our Alps, which are real polyhedrons of ice, hard and angular in form, with smooth surfaces of cleavage.

MOUNT ST. ELIAS, AND SÉRACS OF THE NEWTON.

Soon the whole valley wakes to life in the sunshine, and avalanches thunder on all sides. Enormous masses of stones, ice, and snow hurtle down from the lofty cliffs, with prolonged rumblings, with explosions and sharp volleys as of musketry, repeated by multitudinous echoes. The snow-avalanches are the most beautiful of all. Their descent lasts whole minutes as they slide down giddy slopes, leaping from cliff to cliff in dazzling white cascades, with a dull, continuous roar, testifying to the enormous weight and velocity of the moving mass. The entire aspect of the mountain walls is sensibly changed; glittering ice-needles, and tangled cross lines of fracture break the uniform whiteness of the huge mass of snow. Innumerable furrows appear traced on every slope, hitherto absolutely smooth and even.

The sun sinks slowly until it touches the peak of Mount St. Elias, then, after seemingly lingering a while, slowly sets, shedding a dazzling light over the whole valley. The air is clear as crystal. Peaks of rock and ice, slender ridges fringed with snow-cornices,

MOUNT ST. ELIAS AND THE THIRD CASCADE OF NEWTON GLACIER (AFTER SUNSET).

furrowed cliffs, worn by the incessant fall of stones and by the great avalanches of ice, all stand out, every detail defined with extraordinary clearness. The temperature has sunk below zero, and silence reigns once more. In its frozen immobility the valley is a symbol of eternal duration, serene and unchangeable.

At nightfall the mist settled down again, and peaks, precipices, and ice-falls were enveloped in a shroud of increasing thickness. Fresh masses of vapour rose from below, spreading in every direction, choking every opening of the glacier, every hollow of its flanks, until by 9 o'clock p.m. we were again imprisoned in the damp chill of the grey fog.

We had not been inactive during these days. On the 21st the guides went down to Sledge Camp and brought up fresh supplies; on the 22nd, in spite of the bad weather, H.R.H. pushed forward at the head of a caravan, and found a track to the second plateau; and on the 23rd, the first loads of stores were transported thither, during a short interval of sunshine.

On the morning of July 24th, two caravans set out in a heavy snowstorm, to carry up a good part of the camp material, and were back by 11 o'clock; two hours later we started all together with the final loads. The snow was still falling thickly, and the refraction of the white mist was blinding. It was impossible to realize the inclination of the slopes. We walked like somnambulists, mistaking shallow depressions for bottomless gulfs, and scraping elbows and packs against walls of snow close beside us which we thought to be flat! Climbing *séracs* or marching along their edges, we appeared to one another as shadowy giants on giddy heights and impossible slopes, plunging apparently into space at every step. One curious phenomenon caused by refraction was that while we could fairly distinguish the outlines of *séracs* about 150 feet distant, we could see nothing that was close to us; and the illusion was so complete that the leading guide occasionally sounded with his axe to ascertain if his next step would fall on the snow or into empty space.

Thus, clambering over some blocks, and skirting others, scarcely conscious of the way, we reached the second plateau. The deep track marked out in the early morning was already snowed over; but the guides showed marvellous ability in re-discovering and following up the trail. The leader of the first party groped about with his feet for the beaten track beneath the snow; outside that track one sank in to the waist, and all progress was impossible; while even on it the snow lay more than knee-deep. We were divided into three parties, leading by turns, for the guide in advance had to work so hard pushing his way through the snow that he could only do short spells.

During one of our brief halts, a guide made the valley echo with the typical, long-drawn mountain cry. His voice had the strangest effect, breaking the silence of the peaks. An answering cry came from Sella, who had remained in the place selected in the early morning for the next camp; and although we were still over forty-five minutes' march from him, his voice was as strong and distinct as though he were only fifty paces off. Soon afterwards, the tents already pitched at the new camp came into sight, and it seemed extraordinary they should be visible at that distance through the mist. It is impossible to judge the extent of one's field of vision in a mist, unless there is some dark object on the snow to direct the eye. Both snow and air give exactly the same impression of uniformly diffused white light. Seeing is no less hard than in the dark. Steering is also very difficult, as we proved when we tried again to sight the tents after having turned our eyes elsewhere; sometimes, looking in every direction, it took us a full minute to discover them, although they were plainly in sight.

At last, about 5.30, we came up with Sella. A little gusty wind had now risen, which drove the snow straight in our faces, and we felt very cold. Hurrying on to the camp, we pitched the remaining tents on firm foundations of snow, formed by treading it down thoroughly. Before long we were all dining together under canvas. We were cheerful in spite of weather, for our confidence in the success of the expedition was unshaken. The slightest lifting of the mist sufficed to dispel whatever doubt the inclemency of the weather and the continual fall of fresh snow might have awakened. Complicated wagers passed between us as to the height of Mount St. Elias, the result of our ascent, and even as to the day and hour of attaining the summit. We sat talking on into the evening by the faint light of our little Alpine lanterns. By this time there were as much as four hours of real night, and the few candles packed with the provisions came into use. The snow

ST. ELIAS FROM NEWTON VALLEY

fell on the tents with a slight crackling sound. To prevent it from caking, we gave the canvas an occasional shake from inside.

As the accumulation of new-fallen snow must have already effaced every sign of our track, we began to feel rather anxious for our Americans, who would be on the Newton Glacier by now. Accordingly, on the morning of the 25th July, H.R.H. sent three guides back to meet them, and put them in the right way if necessary, while at the same time another party went on ahead to explore the third ice-fall.

The weather showed signs of improvement, with alternations of sleet, mist, and sun. The latter was still pale and hazy, but grew stronger and brighter every day. After being so long wrapped in fog, we now had broken glimpses of the scenery about us. We were not encamped in the middle of the glacier, but near its right edge, close to the southern buttress of the valley. This spur, projecting from the east side of Mount St. Elias, first runs up into a fine peak that is an exact copy, much reduced, of the great summit; and then curves round, clasping a considerable basin surmounted by an ice-peak tipped by a daring white pinnacle that darts up into the sky like an obelisk. This basin, which descends to the second plateau of the Newton, contains a glacier which scales the walls that encircle it, and covers them completely throughout their height. H.R.H. gave it the name of The Savoy Glacier.

The guides sent back by H.R.H. to seek the porters remained absent two entire days, and only returned to camp early on the 27th, a little ahead of the American party. They had found the latter just preparing to go back, after vain attempts to find their way. Besides provisions, they brought us a welcome, though unexpected, packet of letters from Italy, which had come to Yakutat by a coasting vessel, and, thanks to Mr. Hendriksen, had been conveyed by Indians to an appointed place on the Malaspina coast. The weather now cleared up splendidly, and our anxieties vanished. Early in the afternoon we struck camp and all set off, leaving behind one of the

Whymper tents, one stove, the cooking utensils, and some more articles of clothing.

Our march was a short but very fatiguing one, owing to the bad state of the snow. It brought us over the foot of the third ice-fall to the real *séracs*, where the steepest part of the ascent begins. On the previous day a party had gone without loads to beat a track through the snow, taking two hours to cover 250 feet of road, and

SOUTH WALL OF NEWTON GLACIER, AND THE SAVOIA GLACIER AT ITS CONFLUENCE WITH THE NEWTON.

had been followed by a second party with part of the baggage. Nevertheless, we found it hard and unpleasant work to struggle along in deep, uneven ruts, which often gave way under our weight. The next camp was pitched at 7,431 feet, on a narrow strip of snow between a wide *crevasse* and a sheer cliff of *sérac* about 60 feet in height. Fringes of snow were continually breaking off from the narrow cornice at the upper edge of the *sérac*, and slipping down on to our tent-flaps with a rustling as of silk. Our camp was now

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reduced to three tents: one for the guides, one for our party of four, and the small Mummery tent occupied by H.R.H.

The following day, 28th of July, we carried up everything in two journeys to the highest plateau of the Newton Glacier at the top of the valley. By skirting to the right, round the *sérac* overhanging the camp, we managed to climb the mass, and going on to its farthest edge found a deep *crevasse* nearly 100 feet wide yawning at our feet. Fortunately, a narrow snow-ridge projected from the *sérac* on which we stood, and slanted down across the great fissure to the opposite and lower edge. We cautiously ventured on to this slender causeway, taking care to place our feet exactly in the centre, since both sides were precipitous and covered with loose snow that broke away at the slightest touch. The passage effected, we made our way over masses of ice connected by shaky bridges of almost loose snow, most of which were either broken or incomplete. All of us broke through more than once, but by careful use of the rope no accident occurred. Through the great holes with jagged margins produced by these stumbles, we saw mysterious azure caverns deep below, of the most marvellous blue ever created by snow, with a sheen like watered silk, and brilliant, almost metallic reflections. At last we emerged from

CAMP AT THE FOOT OF A SÉRAC, ON THE THIRD CASCADE OF NEWTON GLACIER.

this labyrinth of ice-blocks at the head of the ice-fall in the great upper basin of the Newton. At this point the glacier has an undulating surface, and we found it so loaded with snow that the *crevasses*, if there were any, were all hidden. This basin is two miles in width and about three in length, and is overhung by the walls of Mount St. Elias, of the *col* and of Mount Newton.

Turning towards the middle of the plateau, we pitched our camp within a mile of the outlet of the basin, out of reach of the

MOUNT NEWTON FROM THE THIRD CASCADE.

avalanches threatening to fall on every side. We were now at 8,661 feet above sea level.

Directly over us rose the vast pyramid of Mount St. Elias, which had a bulky, flattened aspect, seen thus foreshortened. The almost rectilinear north-north-eastern ridge sloped at a moderate angle, broken here and there by *séracs* which did not look formidable; half-way up and a little below three groups of black crags break the pure snow-line, while above these the *arête* rose without interruption to a huge buttress of ice, beyond which was the rounded dome of the peak. The wall rising to the *col* was rather steep. Save

HURRAH FOR ITALY!

for a triangular rock-island exactly in the middle, it was entirely covered with snow; above, and to the right of this cliff, the slope was broken up into *séracs*; but towards the left it showed smooth, and looked easy of ascent, although not quite free from danger of avalanches of ice and stones from the north-east flank of Mount St. Elias.

MOUNT ST. ELIAS, FROM THE THIRD NEWTON CASCADE.

On the 29th of July, three guides started ahead to pick out the way and cut steps up the wall of the *col.* H.R.H., with a small party, returned down to our preceding camp to bring up provisions. The light mists which had floated all day about the mountain sides and peaks melted away in the cool of the evening, and a cloudless night began.

CHAPTER VIII

The Ascent of Mount St. Elias

CALLED up at 1 o'clock a.m. (July 30th), we set about preparing for the penultimate stage of the ascent. The *col* between Mount Newton and St. Elias was to be climbed that day. Thence we hoped, by the long north-east ridge, to win the great peak on the following morning. So confident were we now of success that hope amounted almost to certainty. The supplies to be taken with us had been most carefully chosen, and comprised the following articles :—

Two Whymper tents, ten sleeping bags, rations for two and a half days, one petroleum cooking stove, one spirit lamp ditto, meteorological instruments, the smaller of Sella's photographic machines, Gonella's small camera, and a few extra flannels.

We started at 4 o'clock, divided into three parties, along the route marked out by the guides, who had prepared a track right up to the *col* on the previous day. It was a bright, cold morning, with a perfectly clear sky. The snow was firm enough in the beaten track, but loose everywhere else, and covered with a thin crust of ice that gave under our feet. The strip of plateau, extending for about two miles and a half ahead to the flank of the *col*, lies at the very foot of the north-east face of St. Elias. This face is rocky at the steeper parts, but showed almost everywhere a coating of ice overlapping its precipices that threatened us with formidable avalanches. The condition of the snow warned us of this danger, seeing that for a stretch of over one mile it was no lónger loose, but hardened avalanche snow, which crackled under the nails of our shoes, and was thickly sprinkled with *sérac* fragments fallen from a height of over 3,000 feet. Fortunately for us, most of the accumulated fresh snow had already come down during the past three days of fine weather, and the rest of it

MOUNT ST. ELIAS AND RUSSELL COL, FROM THE SECOND PLATFORM OF THE NEWTON GLACIER.

A. Camp on the Second Plateau. B. Camp on the Third Plateau.

had had time to harden a little; but what chiefly served to keep the ice safely bound to the precipitous rocks was the intense cold of early morning.

After about an hour's march, the slope of the glacier gradually began to increase, and we soon reached the foot of the cliff where the real ascent begins. The wall rises in a series of somewhat steep slopes, separated by great transversal *crevasses*, and varying from 400 to 600 feet in height. We zig-zagged obliquely up these snow-slopes, the surface of which was pretty good for long stretches, where the guides had found it necessary to cut steps on the previous day. The first *crevasse* immediately beneath the isolated rock that projects from the middle of the wall cost us some trouble, and nearly half an hour's labour. The first two caravans crossed it easily enough by a snow-bridge, but this broke down when attempted by Sella, the leader of the third rope. After searching vainly for some solid foothold on the snow-vault, the third party finally managed to reach the other side by leaping boldly across the gap in the bridge. But the last guide unluckily dropped his jacket as he jumped, and had to be let down to a good depth in the fissure to recover it.

CLIMBING RUSSELL COL.

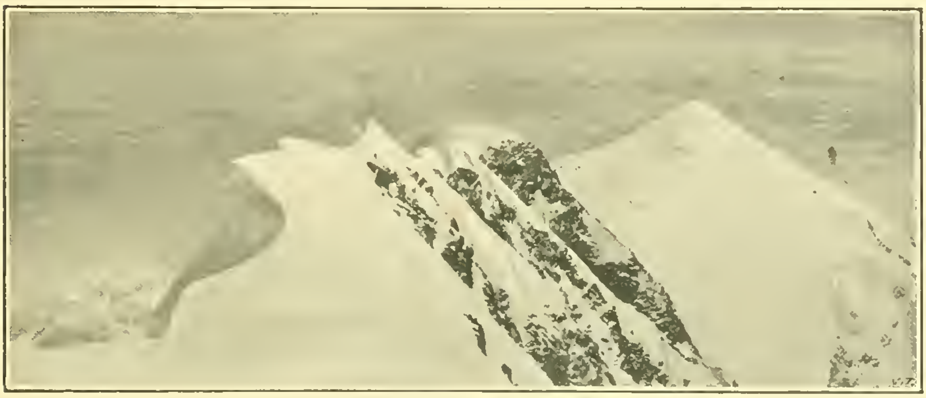
Keeping to the left of the rocks, we then mounted to the second *crevasse*, which cuts straight across the steep incline in such a way that its upper edge overlaps the lower one like a roof, leaving an interval of about seven feet. At a short distance, however, along the lower side, we discovered a point where the edges drew a little closer together. By mounting on a guide's shoulders, we managed to get safely across, and our loads were hauled up after us. Another snow-slope, a last and easily negotiated *crevasse*, and then, at about 10 o'clock a.m., we landed on the top of the *col*.

Our tents were pitched a little beneath the crest, on the east side, facing the Newton Glacier, 12,297 feet above the sea, and 3,636 feet higher than our previous camp. H.R.H. named the *col* after I. C. Russell, who was the first to conquer it, in 1891.

As soon as we reached the *col*, we turned eager glances to the new region revealed to us towards the north-west. At our feet we

beheld a very extensive level glacier, covered with snow, and with no signs of *crevasses*; but its eastern and western boundaries were hidden from us by the mountains at either side. Beyond the portion fronting us lay an interminable stretch of snow and ice, an infinite series of low mountain chains bristling with numberless jagged, sharp-pointed and precipitous peaks, where rocks and ice-fields were closely intermingled. Towards the horizon we had a confused view of some very high ranges. We realized that from the summit we should see the whole of this region more distinctly mapped out.

The view to the north was blocked by Mount Newton, which



MOUNT NEWTON, FROM RUSSELL COL.

now took the shape of a sharp-pointed snow-cone. Just to its left, and farther back, we discerned the pinnacled rock forming the western extremity of the Logan chain. From Mount Newton an irregular ridge runs down to the *col*, edged, to the north, by a bulky snow-cornice, and cut by deep indentations forming the heads of the gullies of stones and ice which score the mountain side towards Newton Glacier. The great ridge of Mount St. Elias is of wholly dissimilar structure, for being so wide it resembles a *slope*, and cannot be easily identified with the even, straight crest seen from below. Viewed from the *col*, it appears to be broken by projections of varying steepness, amongst which three distinct clusters of rocks rise above the snow; while the wide, rounded summit seems to soar upwards at a short distance from the last group of crags, and apparently very little higher; whereas, from the valley below, these rocks seemed to stand about midway between the *col* and the summit of the mountain.

Beneath the Newton and St. Elias ridges the mountain sides become precipitous. Masses of snow, ice, and rock, set loose by the first rays of the morning sun, thunder and hurtle down into the valley with a roar which reaches us distinctly, raising clouds of pulverized ice in their descent.

More than 3,000 feet below us the spacious Newton valley descends to the east. At this distance the ice-cascades, with their piled *séracs*, seem mere tracts of rugged, wrinkled glacier between the smooth, level plateaux. We identify all the peaks around us, and in the depth beneath, the white, flat stretch of the Malaspina Glacier, bounded by its black lines of forest and marginal moraine. Beyond, and more than 62 miles off, lies the blue expanse of Yakutat Bay.

N.N.E. RIDGE OF MOUNT ST. ELIAS, FROM RUSSELL COL.

The afternoon hours pass rapidly and almost unheeded, and the pure cold evening is an omen of splendid weather for the morrow. Northwards all is cold shade under a steel blue sky, but the rest of the horizon is orange red. Little by little Mount Augusta crimsons like a fiery volcano. The thermometer is at 18° Fahr., and a chill north-west wind drives us to our tents. Lying down closely packed in these narrow shelters, we try to get some rest to fit us for the last and most serious effort; but most of us are too excited by the thought of the morrow's task to be able to sleep.

At midnight we all turn out, and swallow a bowl of hot coffee before packing the loads. These consist of one day's rations, a small spirit stove, a mercurial barometer, two aneroids, a hygrometer, spirit and mercurial thermometer, and photographic apparatus. The night is perfectly clear and still; Venus shines serenely over the summit of Mount Newton. The temperature stands at 18° Fahr. We are roped in three separate parties. H.R.H., Lieutenant Cagni, the two guides Petigax and Maquignaz are on the first rope; Gonella

THE REGION TO THE EAST OF MOUNT ST. ELIAS, TRAVERSED BY THE EXPEDITION, VIEWED FROM RUSSELL COL.

with Croux and Botta on the second; Sella and myself with Pellissier on the third. We are too excited to talk. We feel that we are on the very point of realizing the hope which has sustained us through prolonged days of toil and through the painful anxiety which, during the last stages, kept us questioning the barometer or the direction of the wind every few minutes.

The crest of the ridge where it reaches the *col* forms an ice cliff, which we skirt on the right. The powdery surface snow is very unequally distributed, here and there leaving uncovered the harder layer beneath, in which steps have to be cut by the first guide. Petigax and Maquignaz go on in front, each taking the lead for half an hour in turn, and we all mount rapidly at a steady pace.

On reaching the top of the cliff, we cross to the east flank of the ridge running down to Newton Valley, where the snow is firmer, being more exposed to the sun. The surface is uneven and ribbed, reminding us of winter snow-slopes in the Alps.

After about an hour's climb, we come to the first rocks, which are formed of black splinters of *diorite*, round which we soon make our way through the snow. A little higher up, while skirting a fissured hump of ice, blasts of frozen north wind drive the powdery snow against our faces. Far above us, the summit is gilded by the first rays of the sun, and gradually the great golden disk rises to the right of Mount Newton. As we climb higher, this summit rapidly sinks, and before long we see its peak beneath us, while behind it, and more than twenty miles off, rises the south flank of the Logan chain. Towards 5 o'clock a.m. we reached the last crags, and speedily surmounted them.[1]

Our ascent was favoured by completely calm weather, and an ideal temperature, unusual in the high mountains, neither inconveniently cold nor oppressively hot. At 6.30, H.R.H. called a short halt; we breakfasted and were off again in half an hour. Soon the aneroids proved that we had reached the altitude of Mont Blanc (about 15,700 feet), and some of our party began to feel the diminished pressure in the shape of palpitation and difficult breathing, which although too slight to impede progress, yet sufficed to suggest that some of us might be prevented from reaching the summit.

At 8 o'clock Cagni arranged his instruments and took meteorological observations. We were now at an altitude of over 16,500

[1] These crags (about 14,500 feet above the sea) form the highest point attained by Russell in 1891. In making the ascent, one does not approach the intermediate rock-group seen from below, but passes it at some distance to the left.

feet; and the temperature was 16° to 17° Fahr. There was an extraordinarily fine view to the east. The peak of Mount Augusta, although now beneath our level, preserved its daring grandeur of outline. But the Logan chain to the north was the most majestic of all. On our right, stretched the vast, precipitous north crest of St. Elias, all rocky save the upper portion, which was covered with snow. About midway it is broken by a towering crag, at whose feet a small glacier descends from the ridge. Around us there was nothing but dazzling snow, its whiteness just softened by faint opalescent tinges of colour.

The observations being duly registered, we resume our way up the tiring, monotonous slope. Less than 1,600 feet now separate us from the summit, but they will cost us more labour than the 4,200 already won. Almost all of us are suffering more or less from the rarefaction of the air, some being attacked by headache, others by serious difficulty of breathing and general exhaustion. H.R.H. slackens the pace of his caravan, and sometimes calls a halt, to wait for those who have fallen in the rear. He is determined to keep us all together, knowing the sense of discouragement felt by any one left behind by the rest of the party. The ascent is very monotonous on the whole and perfectly easy, leading either over the great rounded hump of the crest, or along its eastern flank. Luckily there is only a thin stratum of loose snow, so that one barely sinks into it ankle-deep; while now and again we strike a belt of hard snow in which the leading guide has to cut steps with a few strokes of his axe.

Before long we all experience those alternations of hope and disappointment which are typical symptoms of over-fatigue. Every slope ahead seems as though it must be the last; every ice pinnacle is mistaken for the great *gendarme* near the top of the crest which we had discerned from below. Even the guides make strange blunders regarding the extent of slope still to be won.

Our rate of progress is now of the slowest. We climb for ten minutes, and then rest for five or six. One or two of us lie down panting on the snow; some sit or crouch, while others take their rest standing, and lean on their ice-axes. H.R.H., Sella, and two of the guides are the only persons showing no signs of distress. Gonella suffers from headache; Cagni, myself, and Botta have to fight against the drowsiness which comes over us at every halt. The two remaining guides have slight symptoms of mountain sickness.[1]

Our legs seem heavy as lead. Every step requires a distinct effort of the will, and we get on by dint of certain devices familiar to all who have made ascents when tired out—leaning both hands on the knees, or planting the axe in the snow ahead and dragging the body up by it, while at every step we pause for breath. Still, we manage to climb somehow; we are spurred on by excitement, and our nerves are strung to the highest pitch.

At last, after untold disappointments, a little after 11 o'clock, a sharp ice-pinnacle soared above us, and to the right of it and somewhat higher, the ample curve of a snow-dome. For some minutes past no one had spoken a word. Suddenly we all exclaimed: "The summit!" Only an ice-slope about 150 feet high had still to be surmounted. It was steep, and in our exhausted condition we had to attack it in a slanting direction, resting for breath every few steps. On reaching the top of this incline, we again came to a halt. Before us rose gently towards the west a slope which, in the dazzling light, appeared to be of vast extent. We had actually passed from the crest to the eastern limit of the terminal dome, and scarcely realized that we were so near to the summit.

The leading caravan started ahead, the two others lagged about 150 feet behind. Suddenly we saw the leading guides, Petigax and Maquignaz, move aside to make way for the Prince. They were within a few paces of the top. H.R.H. stepped forward, and was the first to plant his foot on the summit. We hastened breathlessly to join in his triumphant hurrah!

[1] In Appendix C, I have given a more detailed analysis of our "mountain sickness."

Every trace of fatigue disappeared in the joy of success. This moment was the reward of our thirty-eight days of labour and hardship.

It was the 31st of July, a quarter to 12 a.m. A few minutes later, H.R.H. hoisted our little tricolour flag on an ice-axe, and we nine gathered round him to join in his hearty shout for Italy and the king. Then all pressed the hand of the Prince, who had so skilfully led the expedition, and had maintained our courage and strength to the last by the force of his inspiring example.

Our excitement was of short duration. Once our object attained, we experienced the inevitable reaction after so many months devoted to the pursuit of one idea. Nevertheless, it was needful to pull ourselves together, and set to work taking observations. It was the most favourable hour for them. At mid-day, Mr. Hendriksen, at Yakutat, always registered the indications given by the meteorological instruments we had left in his charge. Therefore it was most important that simultaneous observations should be noted on the summit of St. Elias. The Fortin barometer marked a pressure of 15 inches 2 lines. With the due corrections and rectifications, it indicated an altitude of 18,090 feet, which very nearly agreed with the angular calculation made by Mr. Russell in 1891, fixing the height at 18,100 feet. All preceding calculations had proved discordant and untrustworthy. Only one gave an approximately correct result; namely, that made by the Italian navigator Malaspina in 1792, fixing the altitude of Mount St. Elias at 17,847 feet.[1]

We had risen 5,793 feet from the *col* to the summit. The ascent had occupied ten hours and a half; but we must deduct from this the thirty minutes spent over lunch, and another half-

[1] In chap. iv. I have already given the principal observations on the altitude of Mount St. Elias, taken by explorers of that region. I now add the most recent, made in 1892–93, by J. E. MacGrath, of the "U.S. Coast Survey," kindly communicated to us by Prof. J. C. Russell. This fixes the height of Mount St. Elias at 18,024 feet.

hour devoted to meteorological observations. During the first five hours we had climbed 3,400 feet, at an average rate of 680 feet per hour; and 2,400 feet in the last four hours and a half, at an average rate of about 600 feet an hour.

The summit of Mount St. Elias consists of a spacious plateau stretching, with a slight inclination, from south-east to north-west. The highest point stands north, and forms a raised platform about 40 square yards in extent. The temperature in the sun stood at 10° Fahr.; there was no wind, but a light breeze sufficed to chill us. We found some shelter a few yards from the top, and without leaving the terminal dome. Here we sat down to take some refreshment, trying to overcome the repugnance to food induced by fatigue and mountain sickness.

Beneath us, on every side, lay an indescribable panorama, glittering in the intense mid-day light. Only the Malaspina Glacier and the sea were covered by a low-hanging curtain of fog; in every other direction the horizon was perfectly clear. The enormous extent of snow-fields, glaciers, and mountains revealed to our sight, surpassed all imagination.[1]

Those majestic peaks which two days before towered above us, while we were painfully struggling through the snows of Newton Glacier, now lay at our feet. We traced along the valleys the long course we had followed, while memory recalled difficulties and obstacles now lost in the distance. Often had we turned longing glances from the depths towards this small ledge outlined against the sky, as if imploring encouragement from the lofty summit!

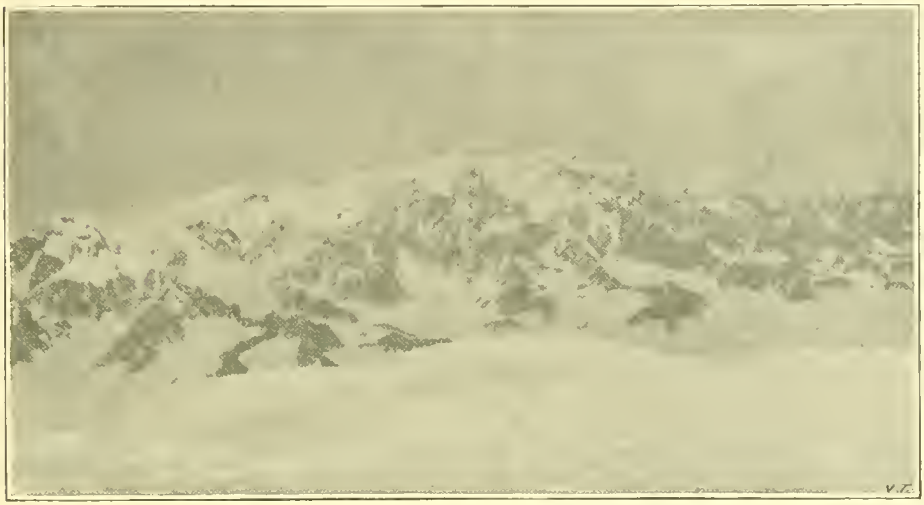
The peak of Mount Augusta, still imposing, although nearly 4,000 feet below us, now assumed the form of a huge pyramid, turning a rocky face southwards, but covered, on the north side, with ice that spreads up to the terminal cupola. Beyond the Seward Glacier soars Mount Cook; and to the left of this another and more remote snow-summit, that must be either Mount

[1] *Vide* the panoramic views III. and IV. at the end of the volume.

THE RIDGE OF MT. LOGAN SEEN FROM ST. ELIAS

Hubbard or Mount Irving, but which of the two it is hard to decide. From the sea of mist shrouding the Malaspina Glacier, the higher peaks of the Samovar and Hitchcock chains thrust up like isolated rocks. Lastly, in the far distance, to the south-east, we distinguish the summit of Mount Fairweather.

About twenty miles away to the north, and running parallel with the Newton-Augusta range, we see the vast chain of Mount Logan, the sole competitor disputing the supremacy of Mount St. Elias.[1] The lengthy crest constituting its summit rises gradually from



MOUNT LOGAN, FROM THE SUMMIT OF MOUNT ST. ELIAS.

west to east, in an almost uninterrupted *arête*, without depressions or deep *cols*, broken only by a few rocky pinnacles and ice-domes,

[1] Mr. Russell, who first discovered and gave a name to this mountain in 1890, assigned it a height of 19,500 feet. J. E. MacGrath gave it that of 19,539 feet. As far back as 1838, Topham had already judged that the highest point of the mountain system would be found north of St. Elias, having observed that the chief bulk of the Guyot and Malaspina Glaciers came down from the region situated north and north-east of that peak. From the summit of St. Elias, we failed to prove the superior height of Mount Logan; at so great a distance, observation with the prismatic compass gave only negative results. Later on, however, during the return voyage off the Fairweather coast, we noticed that the Logan peak disappeared from the horizon, while the whole terminal cone of St. Elias was still clearly visible. Russell had already made the same observation in 1891.

and reaching its greatest height in a snow-peak at the eastern extremity. After this point the crest makes a sudden dip, running on in a series of lesser heights, which, after bounding the north side of Seward Glacier, turn in a wide curve towards Mount Cook, and are then blocked from view by Mount Augusta. Likewise, to the west, the crest falls rapidly, and ends in a series of short spurs among the lower hills.

The southern face of the chain, which is in full view from base to summit, is about 10,000 feet high, and extremely wild and picturesque. Throughout the whole extent it is composed of precipitous crags, intersected by piled glaciers, having the aspect of avalanches suddenly checked in their career down the very steep incline, and frozen fast to the rocks. Short, low spurs start from the base of the great wall, and project into the Seward Glacier; while the numerous ice-fields filling the intervening hollows cover the foot of the chain, and run up it in wedges here and there to a considerable height.

The space lying between Mount Logan and the Newton-Augusta chain forms the basin from which the Seward Glacier takes its origin, and its size is duly proportioned to the great ice-stream issuing from it. From the western extremity of Mount Logan starts a ridge stretching farther south than the others, apparently running into the Newton-Augusta chain, thus closing the Seward basin on the west, and separating it from another huge glacier that spreads to the feet of Russell Col, and of the north and north-west flanks of St. Elias. This glacier, of even greater extent than the Seward, forms a vast snow-level showing no fissures on its surface. We could trace its course for a long distance westward, without being able to determine how and where it comes to an end. The ridge which appears to divide it from the Seward is certainly very low, and seems to run uninterruptedly between the two glaciers, but it cannot be traced very clearly from the summit of St. Elias. As to the new glacier now discovered, the absence of *crevasses*, and the difficulty of distinguishing the real trend of smooth slopes of snow from a lofty post, made it impossible to form any decided opinion as to the direction of this new current of ice—whether it finally issued to the west or the north. Its course seemed to us to lie at about the same level as the second plateau of the Newton; *i.e.*, at from 6,400 to 6,500 feet. H.R.H. gave it the name of "Columbus Glacier."

The whole north-west region to the left of Mount Logan is an unexplored waste of glaciers and mountains, a vast zone bristling with sharp peaks and crags, rugged and precipitous to the south, snow-covered to the north, and surrounded by vast snow-fields free from *crevasses*, and connected with each other by the snowy *cols* of the mountain chains. The medium altitude of the snow-fields is about 7,000 feet, that of the mountains from 9,000 to 10,000 feet. No words can express the desolation of this immeasurable waste of ice, which Russell has compared with the ice-sheet that covers Greenland. No smallest trace of vegetation can be discerned on it, no running water, no lake. It might be a tract of primitive chaos untouched by the harmonizing forces of nature. Surveying this strange scene, we realized for the first time that we were close to the limits of the mysterious Polar world. Such is the region forming the north-west boundary of the Columbus Glacier. Numerous tributaries pour into the latter from the lower hills; and the most considerable of these affluents, running into the Columbus on the immediate left of Mount Logan, was named by H.R.H. after Quintino Sella, the illustrious pioneer of Italian Alpinism.

On the far horizon, somewhere between fifty and one hundred miles off, a broad summit towered up behind the western corner of Mount Logan, which was ascertained by the compass to be at 328°. H.R.H. named this peak "Lucania," in remembrance of the ship that had brought us to America. West of this new peak, at about the same distance and due north of St. Elias, we descried another great mountain at 326°, which we believed to be identical with the peak christened Mount Bear by Russell in 1891. Finally, to the north-west, some 200 miles off, a conical peak soared up at 311°, apparently of even greater height than the other two. This was christened the "Bona," after a racing yacht then belonging to H.R.H. These three peaks really seem to rival Mount St. Elias in height, and must approach 18,000 feet in height. None of them showed any sign of volcanic activity.

While we scanned the wide prospect, endeavouring to fix in our memory each detail of the wondrous scene, multitudinous thoughts and feelings crowded upon us. The labyrinth of dark lines, the pure white plains, the chaos of rock and ice, blended in our minds with familiar scenes of marvellous beauty in our own Alpine world.

But sheer physical weariness soon unfits the mind for contemplation of so much supernatural grandeur. We feel vaguely crushed by the immensity; a desolating sense of isolation comes to us from those infinite wastes of ice, and from the solemn, oppressive silence of nature. Once the first excitement worn off, we are dazed by the radiance of the sunlight striking through the cold air; we suffer from distress caused by the altitude, and before long our only desire is to hasten down the peak as fast as we can.

By 1 o'clock p.m. we had gathered up our few possessions, arranged the different caravans, and begun the descent in the same order observed during the climb. We had spent an hour and a half on the summit.

Long glissades bore us quickly down the slopes we had so laboriously toiled up, and the few *crevasses*, being mostly filled with snow, were easily crossed. A little wind blowing in sudden gusts swept the face of the mountain, and assailed us with volleys of icy dust. As we drew near to the *col* the snow was in worse condition, and we had to plough through it knee-deep for long intervals. Nevertheless, we got on fast, slipping, falling, regaining our feet, plastered with snow from head to foot, but eager to reach camp, to

escape from all that blinding, white glare, into the comforting shade of our tents. Between 4 and 5 o'clock p.m. we overtook on the *col* H.R.H.'s caravan, which had descended the great snow-slope in two hours and a half.

We had only a little broken sleep that night, and awoke early on the 1st of August in a very battered, aching, and stiffened condition. The same evening we camped again on the upper Newton plateau.

CHAPTER IX

Return from Mount St. Elias to Yakutat

ON the 2nd of August, the morning after our ascent of the peak, we began the long return-journey without even a day's rest. In fact, our downward course was no less hastened by the wish to reach home than our ascent had been spurred by the ambition of winning the summit of Mount St. Elias.

But the nature of our task was totally different. Now, every detail of the route was thoroughly familiar, whereas, during the ascent, every step demanded an alertness of mind and eye that kept us on the strain, in looking out for obstacles ahead, and devising ways to overcome them before they were reached.

Everything had been carefully arranged beforehand to avoid delay in the descent. As we had no reason to fear unexpected obstacles, our equipment was now reduced to the barest necessities, and we were free from anxiety with regard to supplies. H.R.H., with wise forethought, had made the porters deposit stores of provisions at certain points along the route, carefully chosen so as to correspond with the length of each day's march. Naturally, the stages were twice or even three times as long as those accomplished on the ascent; so that on the way down we only

made nine camps instead of twenty-one. But the halting-places selected were usually on the site of our former encampments.

On the 2nd of August, therefore, we left the upper basin and went down to the third ice-fall of the Newton. The snow was so bad even on the track that we sank in knee-deep at every few steps. As all carried heavy loads, the march was both slow and laborious. The ice-bridges were insecure and some of them broken down, so that fresh passages had to be found across the *crevasses*. Presently, too, the fine weather of the previous days began to change for the worse. Great banks of violet-hued clouds obscured the eastern sky; the Augusta chain was suffused with a pale, livid light, as one summit after another disappeared; while Mount Augusta itself was swathed in thick clouds, until gradually the whole prospect was blotted out. Mount St. Elias was the last peak to vanish.

We camped on the second plateau of the Newton, near the mouth of the Savoy Glacier, where, on the way up, we had left one of the Whymper tents two feet deep in the snow. But during the past five days of fine weather, the surface of the glacier had melted to such an extent that the site of this tent, being sheltered from the rays of the sun, now emerged like a small terrace above the surrounding ice.

We passed the whole of the next day (3rd August) in this camp, waiting for the American porters and re-arranging the packs. About 11 o'clock, a distant shout was heard across the misty level. Standing outside the tents, we watched with strange emotion the approach of shadowy forms struggling slowly up through the heavily falling snow. At a hundred paces from us, their leader, Ingraham, halted, shouting out, "Did you reach the top?" "Yes." "All of you?" "All of us!" Their loud hurrahs echoed through the valley, and we again felt the exultation of that moment of victory as though it had been scarcely realized before.

Ingraham had only five men with him. The rest had gone back to Yakutat to resume their work as sailors on board the *Aggie*. With the help of these porters, we were able to carry down the whole of the baggage, and so had not to retrace our steps and fetch it by instalments.

That evening the weather cleared again and became really fine. The valley slumbered in shadow, while the summits above us glistened softly in the moonlight.

On the 4th of August, after crossing the second Newton plateau, we descended the long ice-fall leading to the lower level, and proceeded as far as the little lake among the *séracs*, where we had camped on the way up. The peaks were now wreathed with swirling mists that assumed a thousand different shapes as they drove hither and thither in the wind. Mount St. Elias towered sullenly over the huge cloud-banks hanging about its flanks. Still heavier mists clung round the *séracs*, pierced here and there by rays of sunlight reflected in countless iridescent rays from the masses of ice; while avalanches thundered unceasingly down the lofty rock walls.

The scattered detachments of our party, moving far ahead slowly and noiselessly over steep *séracs*, or crossing treacherous snow-bridges, bore a strange resemblance to men groping their way, and hiding behind boulders to escape lurking foes.

One day's march from the Lake Camp took us over the rest of the Newton Glacier and down to the edge of the Agassiz, where we pitched our tents, saluted, as we emerged from the great valley, by a final salvo from its avalanches. To eyes still dazzled by the immaculate purity of the Newton Glacier, the Agassiz appeared yellow and dirty. We found notable changes in this glacier; the *séracs* were less prominent, the hollows less deep, the whole surface was shrunken and levelled.

On the 6th of August we resumed the tedious labour of portage by sledge. Our baggage was so much reduced that two sledges sufficed to carry it. A march of seven hours took us across the Agassiz Glacier and up to the Dome Pass, in spite of having to manœuvre the sledges over many transversal *crevasses* which had been concealed under firm snow on the ascent; and finally we

[illegible] GLACIER ON [illegible] WAY BACK

went down from Dome Pass to make camp on the west side of the Seward Glacier.

On the 7th and 8th of August we crossed the Seward, and descended the valley by the track we had followed on the ascent; that is to say, by Pinnacle Glacier, and skirting the base of the Hitchcock chain. The weather was now changeable, slight showers of rain alternating with mists and sunshine. But by this time we had become indifferent to moisture, and no longer took pains to keep our tents dry or make ourselves comfortable.

We noticed a marked change in the appearance of the mountains and glaciers. The wintry shroud that enveloped all the slopes

CROSSING AGASSIZ GLACIER ON THE WAY BACK.

a month earlier had now vanished away, the snow-fields had melted, and the imposing ice-falls of the Hitchcocks were reduced to small glaciers flowing down from modest heights. The mountain spurs jutting out into the Malaspina were now black, and apparently much lower. The lofty peaks which encircle the Seward Glacier stood out more grandly and were more impressive in contrast with this dark foreground.

Wherever the melting snow had laid the earth bare, a luxuriant growth of flowering plants had sprung up knee-high with incredible rapidity, rich in colour and fragrance. Mr. Russell's experience was repeated for us, since we too found many different species all blooming at once. Here were summer lupines side by side with spring violets and with autumnal asters and gentians. The warm season is so short in this region that the plants have no time to flower in due succession.

Even the Seward was considerably altered. The drop in the glacier, north of the entrance to Dome Pass, which, on our ascent, was only visible for a brief extent on the flank of the north bastion

FLOWERY SLOPE ON THE HITCHCOCK HILLS.

of Pinnacle Glacier, being cleared of the heavy layer of snow that had masked its outline, was now seen to be a really great ice-fall, spreading across the whole length of the Seward. The surface snow ceases immediately below the junction of the Seward with the Pinnacle Glacier. Accordingly, the limit of perpetual snow in the Mount St. Elias region would lie about 3,000 feet above the level of the sea.[1] Beneath this limit, only irregular patches are

[1] According to Mr. Russell (first expedition, 1890), the snow-limit would be

found of old, yellowish snow on the *séracs*, which display their bare, greenish ice at the sides. Hundreds of blue lakelets are now to be seen among the labyrinth of ice-blocks. At the edges of the glacier, the two dark lines formed by the detritus-soiled *séracs*, which act as marginal moraines, are much more marked than before.

The only spot where we were now compelled to unload the sledges and carry the baggage on our backs was the steep descent from the Pinnacle to the Hitchcock Glacier. On all the other slopes

CROSSING PINNACLE GLACIER ON THE WAY DOWN.

which we had so painfully climbed, bearing heavy packs, the guides managed with remarkable skill and strength to get the sledges down without removing the baggage, now checking their pace with ropes, now executing brilliant glissades, while propping up and supporting

rather lower down, at the terminal cascade of the Seward, *i.e.* at about 2,000 and odd feet. It may be that the snow-line is now retreating: a phenomenon possibly connected with the gradual shrinking of the glaciers in this region of which Russell found proof. Perhaps the same explanation would apply to the difference of the glacier's appearance and rate of movement, as noted by Russell in 1890, from our observations of the same in 1897, to which allusion has been made at page 111.

their cumbersome loads; thereby exciting the earnest admiration of the Americans. Our old track along the strip of snow at the foot of the Hitchcock Hills had now caved in to below the level of the Seward.

On the evening of the 8th of August, we camped in a little cleft of the Hitchcock Hills,[1] near the extremity of the chain. Our tents were pitched on blocks of old snow surrounded by a network of channels which, uniting at the outlet of the depression,

DESCENDING A SNOW-SLOPE AT THE EDGE OF THE SEWARD.

formed a torrent running into the Malaspina through a deep gully in the flank of the Hitchcock. Looking across the narrow *col*, we saw, as if through a window, the immense Malaspina, about 620 feet below us, a huge white expanse with a silvery glitter and glaucous reflections.

Early next morning we carried our baggage down to the Mala-

[1] The same hollow to which Gonella and Sella had climbed the previous month, when seeking the most practicable route for the conveyance of our baggage from the Malaspina up to the Seward Glacier. (*Vide* pages 95–97, and the footnote to page 97).

spina, and descending the Hitchcock gully, found ourselves in the dry bed of the small lake that formerly washed its base. This basin was full of mud and stones, and studded with big lumps of dirty ice, which had previously floated on the surface, and had been deposited at the bottom as the lake emptied. Hence we mounted to the Malaspina moraine, more than half a mile in width, which had been covered with snow at the beginning of July. This brought us to the bare glacier, where we cast off our loads and repacked them on the sledges. At first we found the ice cut by numerous *crevasses*, only a few feet wide, and with a rough, uneven surface bristling with icicles. Presently the *crevasses* grew fewer, the ice became smoother, furrowed by innumerable rivulets, and with scattered holes of varying size and depth, filled with water or slush. The thin crust of ice covering these depressions often gave way, and plunged us knee-deep and more in the freezing water. Some, too, were so broad that it was impossible to avoid them, and we had to wade through the water for a considerable distance. When packing the sledges, we had taken care to place uppermost all articles that would be most hurt by a wetting, but it was hard to keep anything dry.

At about two miles' distance from the moraine, we found a fair depth of snow on the glacier, but it was not continuous, being often interrupted by wide belts of naked ice. Now and then we came to wide, round holes more than 300 feet in diameter, the sides of which converged in the form of a wide-mouthed funnel, at a depth of about 20 to 30 feet. The ice at the bottom of these *entonnoirs* was of the same character as that on the surface of the glacier, and was without cracks or *crevasses.* It may be that these deep hollows in the surface are owed to the falling in of the roofs of lower caverns at a greater depth, once filled with water. Only an occasional small stone was found on the glacier.

The weather was splendid, the air fresh and breezy. The chains were uncovered and particularly distinct, from Mount St. Elias to the heights of Disenchantment Bay. The south ridge of Mount

St. Elias stood out clearly, merging into the long chain of the Chaix Hills, which, as they approached the Malaspina Glacier, assumed a series of strange shapes, which we were long unable to comprehend. For their outlines underwent changes before our eyes, assuming the forms of spires, belfries, minarets, and architectural outlines of fantastic cathedrals, all of which slowly appeared and disappeared, to be succeeded by buildings of lesser height, severely rectilinear. This proved to be the mirage known as "the Silent City," an optical illusion to which this wide ice surface is prone, in common with the burning sands of the desert.[1] The marvellous spectacle continued throughout the whole afternoon.

In the uniform whiteness stretching around us, the eye was continually deceived. Apparently, we could see to a great distance —indeed, to the very horizon; but if one of our party walked a few hundred feet ahead, he would disappear out of sight behind the neighbouring slope that actually limited our vision.

Towards evening, we camped in the centre of the glacier. Abundance of water was easily obtained by digging a small well in the ice. Night fell at 9.30 p.m. On the line of intense whiteness bounding the vast plain of ice at the horizon, a great yellow moon shed irregular splashes of light through the deep indigo clouds massed in the sky. At this latitude the full moon does not mount to the zenith as with us, but describes a low arc in the southern heaven, and speedily disappears to the south-west.

On the following morning (10th of August) at 7.30, under a sullen sky, we resumed our journey over ice and snow, and across extensive belts of slush. During the previous day, we had managed to keep to our proper course by occasionally discovering some signs

[1] Mr. Russell also beheld these phantom cities, at twilight on the sea, among the icebergs at the head of Yakutat Bay. The same phenomenon has been often observed in Glacier Bay, at the front of the Muir Glacier; and in *The Wonders of Alaska*, by Badlam (San Francisco, 1891), the author gives a full account of it at page 130. Possibly, certain marvellous tales reported by prospectors exploring the interior of Alaska in search of gold may have been founded on *mirages* of this kind.

of our former sledge-track. But now all indications failed, and H.R.H. steered the caravan by the compass, as on the ascent. Soon the air began to thicken, and for about two hours we were wrapped in a slight fog that gave signs of increasing. Luckily, a few gusts of wind then rose and drove it away, so that progress became easier.

After three or four hours' march, we noticed that the snow was diminishing, and that the belts of naked ice were becoming wider and more frequent, a sign that we were approaching the brink of the plateau. At last, towards 1 o'clock p.m., on climbing a frozen ridge, we suddenly came in view of the marginal moraine and the bay. Far out at sea, in the sound formed by Manby Point, we clearly distinguished the white sails of the yacht *Aggie*, that was waiting for us off the coast. H.R.H.'s calculations had been so accurate that, aided as we had been on the whole by favourable conditions, we were able, after accomplishing the ascent, to meet the vessel at the very date he had fixed—between the 10th and 11th of August.

We felt as joyful and excited as mariners on sighting land after a long voyage, and not in the least discouraged by the fact that several miles had to be traversed before reaching the moraine.

The tract of glacier before us was completely bare, and sloped gently towards our goal in wide undulations. We hurried over it almost at a run, now pushing the sledges, now holding them back. They slid along the hard surface with the utmost ease, passing over ridges and mounds of ice, leaping cracks and *crevasses* with such tremendous jolts and jars, that every moment we expected to see them shattered to pieces. The guides were as merry as boys, and flew down steep slopes clinging to the sledges.

This part of the glacier was of the same character as the upper end at the base of the mountains. The surface was seamed by countless little torrents of clear water murmuring along beds of transparent ice and ending their course in *crevasses* or in "glacier-mills." These "mills" (*moulins*) are bottomless wells, with marvellous blue walls of changing shades of colour, furrowed and hollowed by streams which dash furiously down them into invisible depths resounding with the roar of hidden waters. Now and then we come to an empty water-tunnel, piercing the glacier obliquely, and more than one is large enough for a man to pass through.

The glacier is either level, with its surface stained by a thin layer of mud and bristling with sharp needles and blades of ice, or undulating and covered with a crust like white coral, composed of minute frost-flowers, cut and jagged in every direction by the effects of the thaw. The appearance of the moraine was so entirely altered that none of us could have recognised the spot whence we started on the ascent without the help of the porters. The latter, having frequently returned there for supplies, had observed the gradual change. On the 1st of July the moraine terminated in a straight line at the edge of the snow, which covered the whole glacier at that date. As the snow melted, long tongues of moraine were displayed, from 600 to 1,000 feet wide, projecting at a sharp angle from the edge of the marginal moraine, and running into the glacier for a mile or so from east to west, divided one from the other by tracts of bare ice a mile or two in width. Russell names these formations "penniform moraines," and they represent portions of "median" moraines.

About 4 o'clock we arrived at the first of these strips. It ran level with the glaciers, and was composed of irregularly mixed boulders and stones of varying size, with bare ice between. We did not dream of unloading the sledges, for no obstacles were now allowed to check our course. In a few minutes a sort of track was made across the moraine, by shovelling aside the bigger blocks for some distance ahead, and we got the sledges along by dint of all tugging together. Then we pushed on in frantic haste, leaping *crevasses* and wading all the rivulets and streams in the way, never losing time to look out the easiest passage, never once turning back. The porters' sledge was capsized, but we righted it on its runners in

ON THE WAY BACK. MA [illegible]

a flash and sped down all the slopes without pausing, barely halting now and then to draw breath before a hard bit. The sledges were half smashed, the loads disordered and all awry; but if things tumbled out they were hastily pitched in again, without stopping the vehicles.

A second tongue of moraine was soon reached and traversed, then another, and we rapidly neared the site of our third camp, at the top of the marginal moraine. We passed it without stopping, and continued our course along a tongue of ice ending in a steep descent towards the nook between the last "penniform" strip and the hem of the marginal moraine. The sledges were borne down the slope by their own impetus, rapidly at first, still held back by the men, but soon to be let go at a headlong speed, and scarcely steered, until they were finally brought to a stop by crashing into the big boulders at the edge of the main frontal moraine. It was lucky their work was done, for they were utterly wrecked.

By this time it was 6 o'clock p.m., and we had been on the march for more than ten hours. We were worn out, but unspeakably glad to be off the ice. The camp was pitched in moraine mud and stones, at the base of some enormous rocks, and close to two sledges, empty tins and split flour-sacks, relics of the last camp of the Bryant expedition. After forty days in the snow, we slept for the first time on stones and ice. In ten days we had come down the whole of the glacier zone that we had taken thirty to ascend.

On the following morning (11th of August) we went down to the shore. Retaining only our instruments, personal equipment, and a few other things, we left all the rest of the baggage behind. At the top of the moraine we turned round to give an affectionate and even regretful farewell to our tents. They had become very weather-stained, leaky, and tattered, but nevertheless showed sturdy fronts, planted down there in the bottom of the gully. They had been our home and safe stronghold in the frozen waste, among dense fogs, heavy rains, and interminable falls of snow, and the humble little erections—mere atoms among gigantic groups of *séracs* or labyrinthine *crevasses*—had nevertheless proved stronger than the elements, good, friendly, and serviceable shelters to the very last.

The moraine was smoother now and less tiring; but after so much marching over soft snow-fields, our feet were unused to treading sharp, shifting stones, and we were all suffering more or less. But two hours of this painful progress brought us to the border of the forest, and we found the tent we had left behind there in perfect preservation, with all its contents intact.

We now followed the bank of the Osar River by the track we had taken in the ascent, only the stream was swollen to thrice its former volume. Much of the way lay through the forest, where we revelled in the greenery, joyfully inhaling the perfume of myriads of flowers, or the balsamic odours of resinous trees, and caressed at every step by the fronds of gigantic ferns waving about us on all sides. It was a real feast for the senses. A thick carpet of soft, elastic moss was pleasant to our feet after the scratches and bruises inflicted by the stony moraine. The strawberry beds were loaded with large juicy fruit, the foliage and clustered berries of the mountain-ash were beginning to turn red, and the dwarf-poplars were covered with great fluffy tassels full of ripe seeds, for the early autumn was at hand.

Going at an easy pace, we reached the shore about mid-day, at the very spot where our first camp had stood.

The *Aggie* was under sail, tacking off the coast. After signalling her with a few shots, she drew near and sent her boats ashore. We immediately began to get our things ready to send on board. But, before we had been an hour on the beach, we were driven wild by the mosquitoes, which were more numerous, more voracious, and more tormenting than in June. They swarmed about us in dense clouds, got into our noses, mouths, eyes, and ears, crawled up our sleeves and down our collars. Before long our faces were like masks, all swollen and blood-stained by the innumerable

[illegible] FROM [illegible]

stings, and the vain slaps and scratchings by which we sought protection or cure.

By evening half our belongings had been sent on board the *Aggie.* Meanwhile the surf, slight enough at first, had grown rather violent, and just as Gonella was pushing off, a big breaker turned the boat bottom-up; but luckily no one was hurt. His next attempt was perfectly successful. Then came my turn and Sella's; and we got off all right at the cost of a good ducking from the spray. H.R.H., Cagni, the guides, and six porters remained on shore,

MOUNTS LOGAN, COOK AND VANCOUVER, FROM YAKUTAT BAY.

where they passed a sleepless and most wretched night, incessantly tortured by their insect foes.

Early next morning the transport of the baggage was resumed, and before long everything was shipped. H.R.H. was the last to leave the shore, at 8 o'clock a.m. Our companions came on board so disfigured by venomous bites as to be totally unrecognisable.

We set sail at once, crossed the bay in four hours, and touched at Port Mulgrave, facing the village of Yakutat. Mr. Bryant and the Rev. Mr. Hendriksen were the first to come on board and to congratulate H.R.H. on the success of his expedition.

We spent a wet afternoon in harbour, surrounded by canoes full of inquisitive Indians. On the following morning (13th of August), the weather was superb, and the grand mountain chains were all glittering in the brilliant sunlight, as we glided with spread sails from the bay we had first entered fifty-three days before.

CHECKING THE SLEDGE DOWN A SNOW-SLOPE.

CHAPTER X

Back to Europe—From Yakutat to London

OUR work was done. The long return journey, amid the comforts of civilized life, proved a welcome rest after our experience on the ice.

The passage from Yakutat to Sitka lasted four days, but although we were wedged tight as herrings on the little yacht, the wonderful charm of the scenery made the time seem short. Favoured by splendid weather, we lived almost entirely on deck. Many of us slept there, preferring the fresh night breezes to the close air below decks.

As we steered southwards, the peaks of the Mount St. Elias group sank gradually lower on the horizon, while the crests of the Fairweather chain slipped past us in slow procession. At last, the far northern horizon was only broken by the cloud-like white peak of Mount St. Elias. On the 15th of August, at 180 miles' distance, its summit was still visible above the horizon. Then this too disappeared in the fading glow of a glorious sunset; night fell, a silver moon rose, and later on the heavens were illuminated by the fantastic beams of the Aurora Borealis.

First of all, a great white glare suffused the northern sky, like an aerial reflection of all the splendours of the boundless, snowy wastes we had left. It lay on the horizon in a broad luminous band, shaped in the segment of an arc, and fading off softly towards the zenith, while bounded at its lower limit by a straight line that stood out most distinctly against a background of intensely dark sky. Long rays of pallid light, now single, now clustered, darted slowly from the upper edge of the zone, while the lower rim was continually changing in form. Presently the luminous bow seemed to dissolve, and split into fragments, revealing broad areas of brighter light here and there, interspersed with patches of darkness. These changes were slowly produced by means of a strange flicker-

SITKA AND ITS HARBOUR.

ing of the luminous zone, which meanwhile grew paler and paler, until the whole dazzling vision disappeared.

The next day we sighted the cone of the Edgecumbe volcano that dominates the mouth of the Sitka basin; and on the morning of the 17th August our vessel cast anchor in port.

Three days later we bade farewell to our valiant American porters, who were shipped home on the yacht, while we embarked on the *City of Topeka*, the same steamer on which we had sailed from Seattle in June.

Once more we passed through the still channels of the Alexander Archipelago, between the densely wooded shores, where white glaciers glittered here and there against a green background of massed pines. Once more we felt the soft, melancholy charm of this northern world; once more passed the shores of Columbia, threaded the tortuous straits between Vancouver Island and the continent and entered Puget Sound.

The waters of the archipelago, so still and deserted on our June voyage, were now crowded by little steamers loaded with passengers, horses, and goods, all bound for the North. A whole population was emigrating, rushing towards the gold regions of Yukon and Klondike.

Scarcely more than a month had elapsed since the news had reached America of the discovery of wonderfully rich gold-deposits in the Yukon basin, and already in every part of the world Alaska was the leading theme in newspapers and magazines. That mysterious, almost unknown land had suddenly become the centre of all interest and was being invaded by frantic hordes, hypnotised by the mirage of fabulous wealth and hastening to seek it, undismayed at the defeat of others, or at the sight of victims who had fallen by the way.

SITKA BAY.

The rush showed no sign of slackening, although the season was too advanced to allow any hope of completing the long journey before the terrible Arctic winter set in. All the routes, and particularly the passes at the end of Lynn Canal, were already blocked with emigrants whose progress was checked by the impossibility of transporting their outfits over the frozen passes. The more prudent remained at Juneau; others came back thither in despair after vain attempts to reach the Yukon that year. The aspect of Juneau was totally transformed, and the quiet, regular life of the little northern town completely changed. When we arrived there (at 11 p.m. 21st

August), we found the quay thronged with people and piled with goods; the streets were brilliantly lighted and swarming with noisy, excited men, panting with wild hopes and anxieties. All the shops were still open, while the variety and abundance of their wares showed that Juneau had become a centre of supplies for the mining world.

Landing at Seattle on the 26th of August, we found the same feverish activity everywhere. All business and trade of every class were solely devoted to the Alaskan gold-mines. Steamship and mining agencies had cropped up on all sides; large stores had been opened, stocked with fur coats, gauntlets, boots, weapons, tinned provisions, axes, hatchets, picks and spades, together with all the miscellaneous tools and utensils required by adventurers in a wilderness where none of the necessaries of life can be procured.

On the morning of the 27th, we bade farewell to the Pacific Ocean and started from Seattle by rail. We chose the Canadian route in preference to retracing our steps *via* San Francisco and across the States.

Our present way ran due north from Seattle to British Columbia, through the thick forests covering the greater part of Washington State. But there the timber is being destroyed even faster and over a wider area than in the woodlands south of Seattle. We traversed broad tracts set with thousands of charred trunks, with as many more lying prostrate, slowly decaying, and tangled over by the luxuriant undergrowth of bushes and berries that springs to life in the sunlit spaces between the wrecked trees. In parts where the forest was fired some time ago, the trunks have shed their charred outer bark, and whole hillsides are covered with ghostly white stems. On all sides columns of smoke rise from new clearings, and every narrow dale is filled with a thick whitish vapour. By night, one sees red flames and flashes, fading off into faintest rose-colour, against the darkness above.

In British Columbia the process of colonization seemed much further advanced. Instead of miserable log-huts half buried in

brush, at the roots of charred trunks, we found neat little cottages of planed and even varnished boards, with spacious verandahs. The land is planted with belts of forest between vast pastures, where herds are grazing quietly and colts gallop about.

Beyond the Columbia River, you come to the foothills of the Rockies, mounting through wild little valleys which sometimes contract into wilder gorges. After crossing the chain by a pass over 5,000 feet high, the line runs for many hours among picturesque

AMONG THE CANADIAN ROCKIES.

crags, some shaped like towers, others soaring to sharp dizzy peaks, cleft by deep narrow chimneys, and among ridges set with spikes and points of every shape and size, from which some small glaciers flow down.

On issuing from the mountains, the line traverses the great prairie, which has a thin carpet of greenish yellow grass, and in spite of its dry, sterile aspect, possesses a melancholy charm of its own. The train takes a whole day to cross the waste. The few stations on this part of the line consist of a small wooden house, with perhaps a cowboy or two galloping round it, or a few Red-skins seated in a ring and immovable as statues. These Indians have thin sharp faces and long straight hair, twisted at the back of the neck. They are wrapped from head to foot in large blankets adorned with stripes and tags of gay-coloured stuff.

The turf gradually becomes greener and thicker, and more cattle are scattered over it. We have reached the edge of the desert; we soon behold wide corn-fields, and finally reach Winnipeg, the commercial centre of this vast district.

East of Winnipeg lies the lake region, clothed with low forests of conifers and birches, meagre trees with scanty foliage on this poor soil where smooth round rocks crop up at small intervals above the surface. Among the trees and rocks are countless lakelets, filling every natural hollow of the undulating land. The whole district still shows characteristic traces of the agency of that great continent of ice which spread over Canada during the glacial period.

At Fort William the line touches the northern shore of Lake Superior, and runs along it for a considerable distance. The expanse of water is so vast that the opposite shore is not in sight. The banks are low and entirely covered with dwarf scrub, and the whole is devoid of variety and incident.

At North Bay, on the 1st of September, we left the Montreal train, and turned south on our way to the United States. Our party divided at Toronto. H.R.H. with Lieut. Cagni went straight to New York, while Gonella, Sella, and myself crossed Lake Ontario to snatch a few hours at Niagara.

We left on the following day, after a hurried visit to the Falls (thus acquitting ourselves of a debt owed by all travellers to the States), and reached New York the same evening.

At 11 a.m., on September the 4th, we sailed from America in the *Lucania*.

Six days afterwards we were in St. George's Channel, and put into Liverpool at 10 o'clock p.m.

BACK TO EUROPE—FROM YAKUTAT TO LONDON

Our party broke up in London on the 11th of September, after four months of comradeship rendered intimate by sharing the same hardships, conquering the same obstacles, and rejoicing together on the attainment of a common goal.

APPENDIX A

Equipment

EXCEPTING provisions and a few minor articles, the entire outfit of the expedition was purchased either in Italy or in London, being ordered and got together during the months preceding our departure. The requisite stock of provisions was supplied in San Francisco.

After giving an account of the whole equipment, and especially of that portion of it employed in the glacier zone, I will proceed to describe how it was distributed during the progress of the expedition.

Camp-Material, Personal Baggage, and Miscellaneous Articles.

1. Five large Whymper tents, of waterproofed green canvas, from Edgington's. Two of these tents served to house the reserve stores left on the beach and at the foot of the *moraine*. The other three formed part of the glacier camps.
2. Two small Mummery tents, of the same material.
3. Five large sheets of oilcloth, to put under the flooring of the tents, as a protection from the damp.
4. Five closely-woven narrow carpets or rugs, to protect the flooring of the tents from hob-nailed shoes.
5. Ten folding bedsteads of hollow iron, 10 inches high. Of these, five only were carried with us, as the guides declined those allotted to their share, in order to reduce the weight of the loads.
6. Ten sleeping-sacks $6 \times 2\frac{1}{2}$ feet, with double wadded linings, stuffed with down and covered with strong canvas casings. These were rolled and packed in suitable canvas bags.
7. Two aluminium cooking-stoves. Each of these had two pans: a lower one containing the lamp, and shielding the flame from the wind, together with a double-lined circular stand fitting into the pan and supporting the upper one holding the food. The separate parts all fitted into each other, forming a single cylinder 16 inches in height and 14 in diameter. The two lamps were on the pattern of the Norwegian "Primus" lamp, holding about half a gallon of petroleum. Properly cleaned and attended to, these lamps answer well, consume the oil slowly, and emit no smell.

8. Two small spirit lamps, in portable aluminium pans, which could be kept alight on the march, and used for making tea or bouillon with melted snow, without stopping.

COOKING-STOVE READY FOR TRANSPORT.

9. A rectangular box of enamelled iron, with a perforated lid, containing bowls, knives, forks and spoons, all of aluminium.

10. The personal outfit for every member of the party consisted of one change of outer clothing, one pair of ordinary glacier boots, one pair of boots of double thickness, with a layer of rabbit skin between the soles, on the pattern suggested by the Sellas for winter ascents. A good supply of flannels, but no furs. The latter can only be used in regions where the temperature is perpetually below *zero*. During thaws, they become soaked with moisture, and it is impossible to dry them. Each of us had a waterproof coat, one pair of galoshes, and one pair of slippers to rest our feet after wearing the heavy glacier boots. All these things were packed in waterproof bags.

DETAILS OF PORTABLE COOKING-STOVE.

11. Expecting to have to ford torrents either in the coast zone or on the Malaspina Glacier, as all preceding explorers had done, the expedi-

tion was provided with two pairs of india-rubber salmon-fishing trousers, accompanied with nailed boots of a special make.

12. One box containing extra shoe-nails and various carpenter's and shoemaker's tools, etc.
13. Six pairs of Canadian snow-shoes. As we always found tolerably good snow on the lower glaciers, we had no need of these shoes, and finally left them behind at Sledge Camp, foreseeing that they would be useless on the steep slopes of Newton Glacier. Nevertheless, they would have been serviceable in crossing the plateaux of this glacier. Our Alpine snow-shoes being smaller, lighter, and easier to manage, are better adapted than the Canadian for mountain work.
14. Accessories, consisting of two Italian flags, five aluminium flasks, twenty pairs of snow-spectacles, five Alpine lanterns, mosquito nettings, etc., etc.
15. Ten Manilla Alpine ropes, each about 100 feet long, and one lighter rope of silk, 160 feet long.
16. Fifteen ice-axes.

Photographic Equipment.[1]

1. One camera obscura of 30 × 40 centimetres, with four double frames for negatives, and one rapid rectilinear lens (Dallmeyer).

   Five dozen London plates (Wratten & Wainwright), measuring 30 × 40 centimetres.

   Two of the "negative" frames and four dozen plates were left at the coast, and the rest of the apparatus at the base of the moraine.

   This camera was only used to take one photograph.
2. One *camera* supplied by Ross & Co. (London) of 10 × 8 inches, with twelve double "negative" frames for films.

   One double anastigmat Ross-Goertz lens ; equiv. focus, 12 inches.

   One telephoto-attachment, 6½ inches focus (Dallmeyer).

   One ordinary three-legged stand, and one low stand specially adapted for telephotographs.

   One screen of deep yellow glass.

   Fifteen dozen medium isochromatic films (Edwards & Co.).

   Five dozen instantaneous isochromatic films (same firm).

   Thirty dozen extra films were left with the stores on the coast.

[1] This list is drawn up from notes furnished by Sella. It does not comprise the two small cameras belonging to H.R.H. and Gonella.

3. One folding Kodak, No. 5, of 7×5 inches, from Eastman & Co. (London), with a rapid lens and stereoscopic lenses. Twenty sensitive "Kodak spools" (Eastman & Co.) of thirty-two exposures each. Ten of these were left at the coast.
4. One pocket red lantern.
5. One black tent for changing negatives in the frames.

Signor Sella notes that the greater number and the best of the photographs were taken with the Kodak. All the panoramic views, except that taken from the north-east crest of St. Elias, at 16,400 feet, were made with the Ross camera of 10×8 inches on "Edwards" films. These films did not answer well, on account of the excessive humidity of the atmosphere, from which they were insufficiently protected. It was not enough to keep the stock of films in hermetically sealed tin or aluminium cases, furnished with strong india-rubber rings, but the same precautions ought to have been adopted for the negative frames before and after placing them in the camera. And for additional security, the boxes should contain some hygroscopic substance. The sensitive ribbon of the Kodak has the advantage of being immediately rolled round a small cylinder after every exposure, so that the surface exposed is protected from damp by the impermeable celluloid ribbon itself. Accordingly, the Kodak seems the best photographic machine for use in very humid climates.

The meteorological instruments and sanitary supplies are described in Appendices B and C.

The expedition was provided with a small stock of utensils for making naturalist collections: such as pots and tubes for preserving specimens in alcohol, arsenical paste for preparing skins, nets for capturing insects and filtering mud; pressing paper for botanical collections, a mineralogical hammer, etc. These materials would have been very useful had the expedition been unexpectedly detained in the forest zone. But as we spent the whole of our time on the ice, devoting our energies to carrying out our enterprise as quickly as possible, there was no time to think of forming botanical and zoological collections on the lower spurs of the chains. So all our materials, excepting the hammer, were left down at the coast. On our return, we profited by the comparatively fair state of the sea to hasten on board, for we knew that, even at our landing-place, the violence of the surf often made it impossible to bring boats inshore for weeks at a time.

The following table gives a list of all the articles of our glacier equipment, with their relative weights :—

	Weight of each separate article.	Total weight.
	lbs.	lbs.
3 Whymper tents	33	99
2 Mummery tents	14	28
5 Oilcloths for tent floors	7	35
5 Rugs for the tents	4	20
5 Folding iron bedsteads	14	70
10 Feather sleeping-sacks	10	100
2 Aluminium cooking-stoves	15	30
2 Portable spirit lamps	3	6
1 Iron case of kitchen utensils		30
12 Bags containing our own and the guides' clothes		575
2 Pairs of salmon-fishing trousers and boots		50
Flasks, spectacles, lanterns, flags, etc.		5
1 Box of shoe-nails, tools, etc.		30
6 Pairs of Canadian snow-shoes		10
10 Alpine ropes of 100 feet and 1 silk rope		50
Photographic equipment		90
Meteorological instruments		40
Sanitary supplies		40
Total		1,308 lbs.

PROVISIONS.

In the course of the narrative, frequent reference is made to the rations of food. The supplies were divided into fifty rations, each of which contained one day's allowance for the whole party, guides included. Each ration consisted of one tin, hermetically soldered, and measuring 45 × 35 × 25 centim., and one canvas bag containing those articles of food which were supplied to us in tins. The total weight of each day's ration was 53 lbs., and consisted of the following articles:—

Contents of the Tin.

Forty Navy biscuits.
3 lbs. of Italian paste for soup.
1 pot of Liebig's extract.
10 capsules of soup extract, each making a cupful.
2 lbs. of cheese.
2 lbs. of lump sugar.
1 lb. of powdered sugar.
1 lb. of chocolate tablets.
½ lb. of coffee, roasted and ground.
⅓ lb. of tea.

1 lb. of dried fruits.
$\frac{1}{3}$ lb. of salt.
1 small pot of pepper.
1 small pot of English mustard
$\frac{1}{2}$ pint of pure olive oil.
$\frac{3}{4}$ pint of rum.
4 candles.
1 box of matches.
1 piece of soap.

Contents of the Canvas Bag.

2 lbs. of compressed beef.
2 lbs. of corned beef.
2 lbs. of tongue, ham, or salmon (in turn).
2 lbs. of preserved vegetables.
1 lb. of fine table bacon.
1 tin of condensed cream.
1 tin of condensed milk.
1 lb. of preserved fruit.
1 lb. of salt butter.
1 lb. of melted butter.
$\frac{1}{2}$ gallon of petroleum.
1 tin of tallow for shoes.

Twenty of the fifty rations were rather differently made up, that is to say, the paste for soup was replaced by ten more biscuits, and another pound of sugar ; and in the respective bags, four tins of English soups, one tin of kola biscuits, and one quart of spirit for the small stoves, took the place of preserved vegetables.

These twenty rations had been specially prepared for use at the higher stages of the ascent. But from the nature of the region traversed, the conditions of existence and climate varied so slightly throughout the expedition that there was no real need to alter the character of the rations.

In addition to the fifty rations, we left ten tins of biscuits at the depôt on the coast ; and there was a reserve of 500 lbs. of biscuits on board the *Aggie*, which could have been landed easily in case of need.

The compositions of the rations will show that they were prepared with a view to the cold climate one might have expected to find among those vast glaciers. But as we were constantly favoured with relatively mild weather, it would have been better to have had less heat-producing and saccharine aliments, and a larger stock of farinaceous food. Nevertheless, the rations answered very well as they were.

On leaving the Malaspina moraine our baggage weighed as follows :—

Outfit and camp material for selves and guides . .	1,308 lbs.
Sixteen rations of food	848 ,,
Equipment and supplies of the American porters . .	990 ,,
Total weight	3,146 ,,

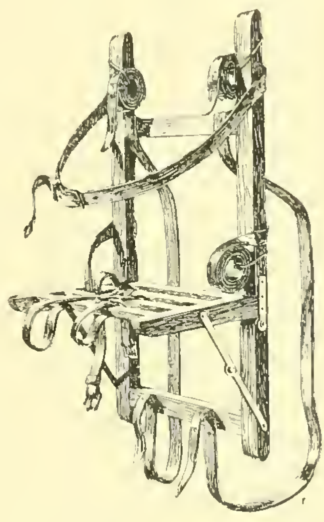
In round figures, we had a weight of 3,000 lbs. divided between four sledges, drawn by sixteen men ; that is, 187 lbs. to each man, reaching over 200 lbs. including the weight of the sledges.

In spite of the heaviness of the loads, and the bad state of the snow, we crossed the Malaspina Glacier in three days, at a medium rate of seven miles the day.

The sledges were built at Seattle, on the pattern of those used for Polar expeditions, and better adapted for travelling over ice than on snow.[1]

Certainly, however, had they been lighter and less substantial they could not have stood the severe jolts and shocks to which they were subjected in passing over the rugged ice of the Malaspina on the way back, when most of the snow had disappeared from its surface.

It might have been useful to have had sledges of an intermediate pattern between these and the very light variety, with wide runners, used by Italian mountain-folk for carrying goods over the winter snow-drifts in the Alps.



THE "SELLA" SHOULDER-PACK.

In our upward progress from Independence Camp, the weight of our baggage steadily diminished both from the daily consumption of stores and the detachment of small parties with due shares of camp material and provisions. But this system of division had the disadvantage of depriving us of the porters' assistance exactly when the difficulties of the way increased the labour of transport by frequently interrupting the course of the sledges. Consequently the baggage had to be subdivided and carried on in several instalments.

At the mouth of the Newton Valley we were forced to leave part of the stores behind, for as everything had then to be carried on our backs, the weight of the entire outfit would have retarded our progress too much. Accordingly the baggage was continually lightened as we went on.

[1] The sledges are described on page 82, chap. v., and their inconveniences recounted.

For carrying our shoulder-loads, we used light wooden frames such as Sella had successfully employed in the Caucasus. We had twenty of these with us. Loads of every size and shape can be easily fixed on them, the weight is comfortably balanced and divided between the shoulders and back, does not impede the breathing, and leaves the arms perfectly free.

In conclusion, the following table will show how the baggage was parcelled out, without reference to the weight of the provisions, which varied continually according to the rate of consumption or replenishment.

Places where we left depôts.	Weight of the baggage.	
	Left behind.	Carried on.
	lbs.	lbs.
On the Malaspina Glacier		1,308
At Independence Camp:		
The waterproof fishing trousers	50	1,258
At Sledge Camp (at the base of Newton Glacier):		
Canadian snow-shoes	10	
Part of the medicinal stores	15	
Part of the photographic apparatus	20	
Waterproofs and clothes	217	
Alpine ropes	20	
Box of tools, nails, etc.	30	
	312	946
Half-way up the second Newton Cascade:		
Five iron beds	70	
Personal luggage	150	
	220	726
At the camp on the second plateau of the Newton:		
One Whymper tent	33	
One oilcloth	7	
One petroleum cooking-stove	15	
One spirit lamp cooking-stove	3	
Box of kitchen utensils	30	
Personal luggage	100	
	188	538
On the third Newton Cascade:		
One Mummery tent	14	
Photographer's black tent	14	
	28	510

Places where we left depôts.	Weight of the baggage.	
	Left behind.	Carried on.
	lbs.	lbs.
At the camp at the base of Russell Col:		
One Mummery tent	14	
Four oilcloths	28	
Five tent rugs	20	
Articles of clothing	80	
Alpine ropes	10	
Some of the meteorological instruments	3	
Photographic materials	30	
Sanitary stores	20	
	205	305
Left on Russell Col:		
Two Whymper tents	66	
Ten sleeping-sacks	100	
One petroleum cooking-stove	15	
	181	124

All the stores left behind at different points were picked up on our return, excepting certain unnecessary articles discarded among the glaciers.

APPENDIX B

Meteorological Observations

By Lieutenant Umberto Cagni, R.I.N.

THE meteorological equipment of the expedition consisted of the following instruments:—

One Mercurial Fortin Barometer, 40 inches in length, with graduated scale from 13 to 32 inches.

One Mercurial Fortin Barometer, specially made for high mountains, 30 inches in length, with graduated scale from 10 to 22 inches. This instrument weighed ¾ lb. less than the other.

One Aluminium Aneroid Barometer of special make, graduated from 12 to 31 inches (Simms, No. 1486).

One Thermometer in a metal case annexed to the preceding instrument.

One Aneroid Barometer, graduated in feet and from 18 to 31 inches; there was, however, no check to the indicator, and under the pneumatic pump it would work well down to 13½ inches.

One Hypsometer or boiling point Thermometer.

One Psychrometer.

One Hair Hygrometer.

Two Spirit Thermometers.

Two Mercurial Thermometers.

One pocket Aneroid Barometer, four small common Compasses, one pocket Prismatic Compass, and one pocket Sextant.

All the instruments were verified and regulated before and after the journey.

Two days before our start from San Francisco, we learnt that no barometer was to be found at the Yakutat Mission, which was to have served as a lower station for observations. Accordingly, a barometer of the Gay-Lussac pattern was purchased to leave there. On reaching Yakutat, we found that the house in which the observations were to be taken was so very low down —only 24 feet above the level of the sea—that the barometric height on the spot would have to be read off from the upper portion of the nonius, opposite to the reading-needle. So, to prevent mistakes, we left the Fortin barometer with the missionary, the Rev. Mr. Hendriksen, and took the Gay-Lussac with us. Convenience made us fix, for taking our observations, the hours of 8 a.m., 12, and 8 p.m., when the Rev. Hendriksen registered them for the American expedition to Mount St. Elias that had started a fortnight in advance of us, led by Mr. Bryant. In this way we gained also the advantage of comparing the two series of observations.

Owing to the subsequent arrangement of our marches, no other set of hours would have been so convenient as these proved to be.

The Fortin barometer, besides its usual leather cover, was additionally protected by an outer case of rough wood lined with straw, on the plan adopted by Mr. Whymper in Alpine ascents. Our success in carrying the instrument uninjured to the summit of Mount St. Elias is entirely due to these precautions. The other mercurial barometer of the Gay-Lussac pattern, having only a solid leather case, came to grief after one month's travel, at the first difficult stage of the mountain. Both the Fortin and Gay-Lussac were carried in our shoulder-packs together with other things ; the two aneroid barometers in their leather cases were slung round our necks. One of these two barometers was spoiled after a time, owing to one of the inner screws getting displaced and impeding the movement of the needle.

The thermometers, hygrometer, psychrometer, and pocket aneroid were all carried in a suitable leather case, which was also fitted with note-books, pencils, compasses, a graduated circle, and a small parallela. As the barometer always worked regularly, the hypsometer was never used.

The total weight of the instruments amounted to 40 lbs., divided as follows :—

	lbs.
One Fortin barometer with case and box	15
One Gay-Lussac barometer and case	8
Case of thermometers, hygrometers, etc.	9
Two aneroid barometers, thermometer, sextant, one box compass .	6
One hypsometer	2

As a rule, all the observations were taken by the same person and at the prescribed hours ; but a few interruptions unavoidably occurred during our marches.

On the return journey, from the 4th of August onwards, owing either to the lack of a mercurial barometer, or to the brevity and irregularity of our halts, we contrived to take only a few observations at the hours corresponding with those at Yakutat, and accordingly it was not worth while to register them. The amount of small hindrances with regard to the proper regulation of the instruments and in taking observations went on increasing as we mounted from the plain to the higher slopes. We could find no means of protecting the instruments from the radiation of the deep layer of snow and ice on which forty-two days of the expedition were spent. At first we carried three extra tent-poles, from which, arranged as a three-legged support, we were able to suspend the instruments at about 3½ feet above the frozen surface ; but soon, as it proved impossible to divide the poles in two, the difficulty of transporting them at full length compelled us to leave them behind. Subsequently we hung the instruments on the outer staying-rope of a tent, or on a small, metal, three-legged stand attached to the barometer case ; but the first method had the disadvantage of keeping the instrument near the tent, and the other, that the little stand generally sank into the snow, so that the barometer was only a few inches above the surface. While it was difficult to shield the instruments from the sun, it was not easy to protect them from rain and snow. A waterproof cape served to cover the barometer, hygrometer, and the maximum and minimum thermometers. But our absence from camp throughout the day prevented any continuous superintendence of our little observatory, and often the very shelter provided for it proved injurious to the proper action of the instruments. A little wind sufficed to set the maximum and minimum thermometers swinging, and alter their readings. Sometimes, it was necessary to take observations when the instruments—some or all of them—had been long exposed to the sun. The aneroids, with their accompanying thermometer, were usually hung with the other instruments, but in rainy weather, particularly on the Newton Glacier, they were consulted in a tent. All this will explain certain anomalies in our observations, and the great divergences now and then found in temperatures read at the same moment, and which had to be regularly registered in order to rectify the instruments. For one week we made use of the psychrometer, but then it was broken. Nevertheless, the few observations obtained served to verify the correction-table of the hygrometer, which on being re-calculated, after our return, was found to be unaltered. The observations taken on the summit of Mount St. Elias were quite accurate, although there was no possibility of protecting the instruments from the midday sun.

As the ascent of Mount St. Elias was the main object of our journey, all else was made subordinate to it. Both time and strength were continually absorbed in the task of climbing, bringing up stores, and planting successive camps with the quickest possible speed. Also, frequent fogs and bad weather contributed to prevent us from carrying out a regular succession of angular and azimuthal observations ; accordingly we have only reported those taken on the summit of Mount St. Elias and from Russell Col. On the other hand, it was deemed advisable to give the entire contents of our meteorological note-books, considering that, presented in this form, the observations registered may be of some use to specialists of the subject. In all these observations instrumental deviations are rectified.

In the thirteenth column, a register is given of the previously corrected medium readings of the two mercurial and spirit thermometers. The maximum and minimum temperatures noted refer to the twelve hours' interval preceding the observation, when the latter was taken at 8 a.m., but refer to a previous interval of four or eight hours only, if the observation was taken at midday or 8 p.m.

The force of the wind is registered on the Beaufort scale (from 0 to 12).

The cloudiness of the sky (nineteenth column) is registered on the scale from 0 to 10.

The altitudes of the different camps were measured by means of the Denza tables, calculated on the Laplace formula, and the figures given indicate the medium of the various heights attained, with the barometric variations found at each spot.

On the other hand, the altitude of Mount St. Elias was calculated according to Senator Siacci's formula, published in 1897.[1]

When calculating the altitude of the nineteenth and twentieth camps, the absence of mercurial-barometer readings obliged us to use the indications of atmospherical pressure afforded by the "Simms" aneroid barometer, No. 1486, which are considered to be fairly accurate.

Meteorological Tables and Altitudes.

Note.—All the numbers were originally calculated on the decimal system. The reduction to English measures was made according to the following values :—

Temperatures : 1° C. $= (1.8 + 32)^\circ$ Fahr.

Barometer readings : given in inches and lines, 1 inch being $= \cdot 0254$ metre.

Altitudes: 1 foot $= \cdot 3048$ metre.

[1] Vide *Atti della Reale Accademia delle Scienze fisiche e materiali di Napoli*, vol. VIII. 2nd series, No. 11.

DATE.	OBSERVATIONS TAKEN BY REV. HENDRIKSEN AT THE MISSION OF YAKUTAT (24 feet above the level of the sea). Hour.	MERCURIAL BAROMETER. Readings.	Temperature.	PSYCHROMETER. Dry Thermometer.	Wet Thermometer.	Wind.	Sky and Atmosphere.	Locality.	Hour.
June 24		—	—	—	—	—	—	**1st Camp** W. shore of Yakutat Bay.	8.30 a.m.
		—	—	—	—	—	—		1 p.m.
	—	—	—	—	—	—	—		8 p.m.
,, 25	8 a.m.	30.0	54.14	51.80	49.10	W.	Cloudy		8 a.m.
	12 noon	30.0	55.40	50.90	47.30	W.	Cloudy		12 noon
	8 p.m.	29.11	54.14	51.26	46.40	W.	Cloudy	**2nd Camp** At the foot of the moraine.	8 p.m.
,, 26	8 a.m.	29.11	54.68	52.70	50.54	W.	Cloudy		8 a.m.
	12 noon	29.11	56.84	52.34	51.56	W.	Clear		12 noon
	8 p.m.	29.11	61.34	59.20	55.40	W.	Clear		8 p.m.
,, 27	8 a.m.	29.11	54.68	50.90	48.20	W.	Foggy		8.30 a.m.
	12 noon	29.11	59.18	54.86	52.34	W.	Clear		2 p.m.
	8 p.m.	29.11	61.88	55.40	51.98	W.	Cloudy		8 p.m.
,, 28	8 a.m.	29.11	56.48	54.50	52.70	W.	Foggy		8 a.m.
	12 noon	29.11	58.64	54.50	43.80	W.	Foggy		12 noon
	8 p.m.	29.11	61.88	55.76	53.60	W.	Clear		8 p.m.
,, 29	8 a.m.	29.11	58.28	53.60	50.90	W.	Foggy	— —	—
	12 noon	29.11	59.54	54.50	53.06	W.	Clear	— —	—
	8 p.m.	29.10	60.98	55.94	52.16	W.	Cloudy	**3rd Camp** At the top of the moraine.	8 p.m.
,, 30	8 a.m.	29.8	56.48	53.96	51.26	N.	Foggy	**4th Camp** At the top of the moraine, few hundred feet from the preceding one.	8 a.m.
	12 noon	29.8	57.38	53.24	50.90	W.	Cloudy		12 noon
	8 p.m.	29.7	65.48	57.56	54.50	W.	Cloudy		8 p.m.
July 1	8 a.m.	29.5	54.68	51.44	50.00	W.	Foggy	— —	—
	12 noon	29.5	56.48	52.70	50.90	W.	Clear	**5th Camp** On the Malaspina Glacier.	12 noon
	8 p.m.	29.5	60.08	58.64	53.60	W.	Clear		8 p.m.
,, 2	8 a.m.	29.11	62.78	56.30	54.50	W.	—	— —	—

OBSERVATIONS TAKEN BY THE EXPEDITION.

MERCURIAL BAROMETER.		Mean Temperature of the Air.	THERMOMETER.		HYGROMETER.		Wind.	Sky.	Atmosphere.	Altitude.
Readings.	Temperature.		Maximum.	Minimum.	Hundredths of Saturation.	Temperature.				
30.0	51.80	49.64	—	—	65.0	54.68	—	Cloudy	Foggy Abundant dew.	
30.0	60.26	59.54	66.20	50.0	53.0	64.4	—	Cloudy	Clear	
30.0	55.40	50.36	59.72	47.48	65.0	51.44	N.N.E. 1	Cumulus 3	Clear	5
30.0	52.88	48.20	—	—	79.5	51.62	N.W. 1	Cloudy	Dark	
30.0	54.14	49.46	54.50	44.60	67.5	51.44	N.W. 2	Cloudy	Dark	
29.11	46.40	46.58	53.60	44.60	65.5	48.20	N. 1	Cumulus 3	Dark	
29.11	52.70	51.80	52.52	42.26	51.0	53.96	N. 1	Clear	Clear	
29.11	59.00	54.54	—	46.40	50.5	53.96	N. 1	Clear	Clear	
29.10	50.00	50.00	—	46.40	65.0	50.0	—	Stratus 2	Foggy	
29.11	56.30	54.54	62.60	41.90	57.0	50.54	—	Clear	Clear	
29.11	60.44	60.80	62.06	53.60	54.5	59.36	N.E. 2	Stratus 3	Clear	47
29.10	51.44	51.80	73.40	42.44	58.0	51.44	N.W. 2	Stratus 2	Clear	
29.11	51.98	51.26	51.80	41.0	59.0	51.44	N.W. 1	Cumulus 9	Dark	
29.11	60.08	57.06	56.82	50.0	59.8	59.0	—	Cumulus 5	Clear	
29.11	53.06	50.90	62.60	50.0	53.0	51.98	—	Clear	Foggy	
—	—	—	—	—	—	—	—	—	—	
—	—	—	—	—	—	—	—	—	—	
29.3	37.40	37.76	—	—	76.0	37.94	—	Clear	Foggy	512
29.1	—	39.20	—	—	—	—	—	—	Foggy	
29.1	42.80	42.80	—	—	—	—	N.W. 1	Cirrus 2	Foggy	551
28.11	37.40	37.94	—	—	69.3	39.02	N.W. 1	—	Foggy	
—	—	—	—	—	—	—	—	—	—	
28.3	48.20	46.04	—	—	52.3	44.96	—	Cumulus 6	Dark	
28.4	40.64	41.0	53.60	37.40	76.0	39.74	N. 1	Cirrus 6	Foggy Abundant dew.	1,007
—	—	—	—	—	—	—	—	—	—	

DATE.	OBSERVATIONS TAKEN BY REV. HENDRIKSEN AT THE MISSION OF YAKUTAT (24 feet above the level of the sea).								
	Hour.	MERCURIAL BAROMETER.		PSYCHROMETER.		Wind.	Sky and Atmosphere.	Locality.	Hour.
		Readings.	Temperature.	Dry Thermometer.	Wet Thermometer.				
July 2	12 noon	29.9	59.18	57.56	56.10	N.	Foggy	**6th Camp** On the Malaspina Glacier.	2.30 p.m.
	8 p.m.	29.9	60.98	56.12	53 96	W.	Cloudy		8 p.m.
" 3	8 a.m.	29.11	57.38	54.50	53.96	E.	Cloudy	— —	—
	12 noon	29.11	56.48	54.50	50.90	S.W.	Rain	— —	—
	8 p.m.	30.0	56.48	54.50	51.80	W.	Rain	**7th Camp** On the Malaspina Glacier, at the foot of the Hitchcock Hills.	8 p.m.
" 4	8 a.m.	30.0	55.94	54.62	50.90	S.W.	Cloudy		8 a.m.
	12 noon	30.1	62.44	53.60	51.22	W.	Clear	— —	—
	8 p.m.	30.1	58.88	53.96	51.80	W.	Cloudy		8.30 p.m.
" 5	8 a.m.	31.1	55.58	53.96	51.80	W.	Cloudy		4.30 a.m.
	12 noon	31.1	55.58	54.62	51.22	W.	Cloudy	— —	—
	8 p.m.	31.1	52.88	51.22	50.0	W.	Cloudy	**8th Camp** On the Seward.	8 p.m.
" 6	8 a.m.	31.1	56.84	50.90	50.36	W.	Cloudy	— —	—
	12 noon	31.1	55.58	52.61	52.61	W.	Cloudy	— —	—
	8 p.m.	31.1	54.68	51.80	50.0	W.	Cloudy	**9th Camp** At the foot of the Hitchcock Glacier.	8 p.m.
" 7	8 a.m.	31.1	54.68	52.61	51.80	W.	Cloudy		8 a.m.
	12 noon	31.1	57.38	53.96	51.80	W.	Clear		12 noon
	8 p.m.	31.1	56.48	53.96	50.0	W.	Cloudy		8 p.m.
" 8	8 a.m.	30.0	55.58	53.60	50.0	W.	Clear	— —	—
	12 noon	30.0	56.48	54.86	50.36	W.	Clear	**10th Camp** Pinnacle Glacier.	12 noon
	8 p.m.	30.1	57.38	57.20	53.60	W.	Clear		8 p.m.
" 9	8 a.m.	30.0	58.28	55.40	51.80	W.	Cloudy	— —	—
	12 noon	30.0	63.68	59.90	54.86	W.	Clear	— —	—
	8 p.m.	30.0	65.48	60.26	55.40	W.	Clear	**11th Camp** At the foot of Pinnacle Cliffs.	8 p.m.
" 10	8 a.m.	30.0	60.08	56.30	52.61	W.	Cloudy		—
	12 noon	29.11	63.68	59.0	53.60	W.	Clear	— —	—

OBSERVATIONS TAKEN BY THE EXPEDITION.

MERCURIAL BAROMETER.		Mean Temperature of the Air.	THERMOMETER.		HYGROMETER.		Wind.	Sky.	Atmosphere.	Altitude.
Readings.	Temperature.		Maximum.	Minimum.	Hundredths of Saturation.	Temperature.				
28.2	39.20	38.90	—	—	69.2	39.92	—	Thick fog	Abundant dew	1,417
28.2	36.14	36.14	41 00	34.34	73.0	36.86	—	Thick fog	Abundant dew	
—	—	—	—	—	—	—	—	—	—	
—	—	—	—	—	—	—	—	—	—	
28.2	37.76	37.76	—	—	78.5	39.02	—	Thick fog	Rain	
28.2	41.00	40.10	40.10	34.34	80.0	41.0	—	Clear	—	
—	—	—	—	—	—	—	—	—	—	1,703
28.2	38.48	37.20	—	36.86	73.0	39.02	—	Cumulus 2	—	
28.2	38.30	37.20	40.64	33.44	—	—	—	Clear	Clear	
—	—	—	—	—	—	—	—	—	—	
27.9	36.32	36.50	—	—	74.0	37.04	N. 1	Cirrus 6	Clear	2,162
—	—	—		—	—	—	—	—	—	
—	—	—	—	—	—	—	—	—	—	
27.6	35.96	34.88	—	—	59.0	39.20	N.E. 1	Foggy	Rain	
27.6	42.08	41.18	47.30	32.9	43.0	46.04	—	Cumulus 5	Foggy	2,454
27.6	54.56	50.0	65.30	39.20	39.0	51.44	—	Cumulus 8	Clear	
27.5	35.60	35.42	75.20	33.40	58.0	40.46	—	Cumulo-Stratus 7	Clear	
—	—	—	—	—	—	—	—	—	—	
26.11	47.30	48.38	—	—	23.0	59.36	—	Stratus 1	Clear	2,979
27.0	43.16	44.24	71.6	57.76	53.5	50.0	—	Clear	Clear	
—	—	—	—	—	—	—	—	—	—	
—	—	—	—	—	—	—	—	—	—	
26.7	46.40	46.36	—	—	46.0	43.16	—	Clear	Clear	3,261
—	—	—	—	—	—	—	—	—	—	
—	—	—	—	—	—	—	—	—	—	

DATE.		OBSERVATIONS TAKEN BY REV. HENDRIKSEN AT THE MISSION OF YAKUTAT (24 feet above the level of the sea).						Locality.	Hour.
	Hour.	MERCURIAL BAROMETER.		PSYCHRO-METER.		Wind.	Sky and Atmosphere.		
		Readings.	Temperature.	Dry Thermometer.	Wet Thermometer.				
July 10	8 p.m.	29.11	62.68	59.54	55.96	W.	Cloudy	**12th Camp** On the Seward, at the foot of Dome Pass.	8 p.m.
„ 11	8 a.m.	29.10	59.18	56.30	55.40	S.E.	Rain		8 a.m.
	12 noon	29.10	60.98	63.86	57.20	S.E.	Cloudy	— —	—
	8 p.m.	29.7	60.08	58.10	54.50	S.E.	Cloudy		9 p.m.
„ 12	8 a.m.	29.9	59.18	57.20	55.40	S.E.	Cloudy		8 a.m.
	12 noon	29.9	60.08	59.0	56.30	S.E.	Cloudy		12 noo
	8 p.m.	29.9	60.44	58.10	51.80	S.E.	Cloudy	**13th Camp** Dome Pass.	8 p.m.
„ 13	8 a.m.	29.6	59.18	55.40	52.16	S.W.	Cloudy		8 a.m.
	12 noon	29.6	61.88	59.0	55.76	W.	Cloudy		12 noo
	8 p.m.	29.6	62.78	59.0	52.70	E.	Rain	**14th Camp** On the Agassiz, at the foot of Dome Pass.	8 p.m.
„ 14	8 a.m.	29.6	60.08	55.76	53.06	S.E.	Rain		8 a.m.
	12 noon	29.8	61.88	59.36	57.20	S.E.	Rain		12 noo
	8 p.m.	29.9	60.08	59.36	54.54	S.E.	Rain		8 p.m.
„ 15	8 a.m.	29.10	58.28	55.40	51.80	S.E.	Cloudy		8 a.m.
	12 noon	29.10	58.28	57.76	52.54	N.E.	Cloudy		12 noo
	8 p.m.	29.10	63.68	57.20	51.80	N.E.	Cloudy	**15th Camp** W. side of Agassiz.	8 p.m.
„ 16	8 a.m.	30.0	58.28	57.76	52.16	S.E.	Rain		6 a.m.
	12 noon	30.1	60.10	59.0	58.10	S.E.	Cloudy	— —	—
	8 p.m.	30.2	60.44	58.10	53.60	S.E.	Cloudy	**16th Camp** On the Newton Glacier, lower plateau.	8 p.m.
„ 17	8 a.m.	30.2	58.28	57.20	51.80	S.E.	Cloudy		8 a.m.
	12 noon	30.2	57.44	58.46	55.40	S.E.	Rain		12 noon
	8 p.m.	30.0	56.30	56.30	50.0	S.E.	Rain		8 p.m.
„ 18	8 a.m.	29.11	53.60	53.96	50.90	S.E.	Rain		8 a.m.
	12 noon	30.0	56.30	57.02	50.0	S.E.	Rain		12 noon
	8 p.m.	30.0	56.30	56.30	50.0	S.E.	Rain		8 p.m.
„ 19	8 a.m.	30.0	54.68	54.86	51.26	S.E.	Cloudy		7.30 a.m

OBSERVATIONS TAKEN BY THE EXPEDITION.

MERCURIAL BAROMETER.		Mean Temperature of the Air.	THERMOMETER.		HYGROMETER.		Wind.	Sky.	Atmosphere.	Altitude.
Readings.	Temperature.		Maximum.	Minimum.	Hundredths of Saturation.	Temperature.				
26.1	38.12	37.76	—	—	55.0	39.74	N. 2	Cumulus 8	Showers	
26.0	43.34	42.26	48.20	34.16	—	—	—	Cum.-Nimbus 10	Showers	
—	—	—	—	—	—	—	—	—	—	
25.11	34.70	35.78	58.10	32.44	73.0	38.12	—	Nimbus 10	Foggy—Rain	3,714
25.10	40.10	39.20	44.60	32.36	62.0	41.18	—	Cumulus 8	Foggy	
25.11	46.40	44.60	56.84	—	49.0	50.0	N. 1	Cumulus 7	Dark	
25.7	35.60	35.42	—	—	86.0	37.04	N. 1	Cumulus 9	Foggy	
25.5	56.30	50.18	—	—	21.0	59.0	—	Cirrus 6	Clear	4,682
25.7	50.0	44.96	49.10	40.64	29.0	54.14	—	Cirro-Cumulus 6	Clear	
25.5	36.14	36.14	—	—	69.0	39.20	E. 1	—	Foggy—Rain	
26.0	45.68	42.62	48.74	32.36	67.0	42.98	—	Cumulus 10	Foggy	
26.1	55.40	45.50	63.50	37.40	50.0	50.0	—	Cumulus 8	Foggy	
26.1	36.68	36.50	58.28	39.70	59.0	38.84	—	—	Foggy—Rain	3,566
26.1	51.80	44.96	53.96	32.36	65.0	42.98	E. 1	—	Foggy	
26.2	55.40	46.40	—	—	58.0	53.06	—	Cumulus 8	Rain	
26.0	35.96	35.96	44.60	32.90	85.0	35.96	—	Cirrus 2	Foggy	
26.2	41.0	41.36	44.24	32.90	67.0	45.34	—	Cirrus 7	Foggy	3,740
—	—	—	—	—	—	—	—	—	—	
25.6	35.24	35.60	—	—	86.0	35.78	S.E. 1	—	—	
25.7	37.40	42.38	49.64	32.36	66.0	38.30	E. 2	—	Foggy—Rain	
25.6	39.20	39.02	47.84	34.16	64.0	40.28	E. 1	—	Rain	
25.5	35.60	35.96	42.24	32.36	82.0	35.78	—	—	Rain	
25.4	40.1	38.48	41.90	32.0	63.0	39.92	—	—	Rain—Snow	4,485
25.5	41.36	42.10	43.70	32.36	68.0	39.74	E. 1	—	Sleet	
25.6	33.40	35.96	48.74	32.36	86.0	33.98	—	Cirro-Cumulus 6	Low fog	
25.8	42.08	39.20	39.56	26.96	46.0	42.80	—	—	—	

DATE.	OBSERVATIONS TAKEN BY REV. HENDRIKSEN AT THE MISSION OF YAKUTAT (24 feet above the level of the sea).								
	Hour.	MERCURIAL BAROMETER.		PSYCHRO-METER.		Wind.	Sky and Atmosphere.	Locality.	Hour.
		Read-ings.	Tempera-ture.	Dry Thermo-meter.	Wet Thermo-meter.				
July 19	12 noon	30.4	57.38	56.84	55.76	W.	Clear	**17th Camp** On the Newton Glacier, second ice-fall.	4 p.m.
	—	—	—	—	—	—	—		6 p.m.
	8 p.m.	30.5	59.18	55.76	52.70	W.	Clear		8 p.m.
,, 20	8 a.m.	30.4	55.58	54.32	50.90	W.	Cloudy		7.30 a.m.
	12 noon	30.4	58.10	56.30	58.96	W.	Cloudy	— —	—
	8 p.m.	30.3	57.20	56.30	54.50	W.	Clear	**18th Camp** On the Newton Glacier, second ice-fall.	8 p.m.
,, 21	8 a.m.	29.10	54.50	53.06	51.26	S.E.	Cloudy		8 a.m.
	12 noon	29.9	54.50	56.34	52.70	S.E.	Cloudy		12 noon
	8 p.m.	29.7	54.68	56.34	50.90	S.E.	Cloudy		8 p.m.
,, 22	8 a.m.	29.7	55.04	54.50	52.70	S.E.	Cloudy		8 a.m.
	12 noon	29.7	56.48	56.34	52.70	S.E.	Cloudy		12 noon
	8 p.m.	29.7	58.64	56.34	50.90	S.E.	Cloudy		8 p.m.
,, 23	8 a.m.	29.7	53.24	53.60	52.34	S.E.	Cloudy		8 a.m.
	12 noon	29.8	56.84	—	—	S.E.	Cloudy		12 noon
	8 p.m.	29.9	59.18	—	—	S.E.	Cloudy		8 p.m.
,, 24	8 a.m.	29.9	54.68	—	—	S.E.	Rain		8 a.m.
	—	—	—	—	—	—	—		10 a.m.
	12 noon	29.9	58.28	—	—	—	—		2 p.m.
	8 p.m.	29.9	53.24	—	—	—	—	**19th Camp** On the Newton Glacier, second plateau.	8 p.m.
,, 25	8 a.m.	29.8	51.80	51.44	50.0	S.E.	Rain		8 a.m.
	12 noon	29.9	54.68	53.60	51.80	S.E.	Cloudy	— —	—
	8 p.m.	29.10	54.68	56.34	50.0	S.E.	Cloudy		8 p.m.
,, 26	8 a.m.	30.0	53.78	53.24	51.80	S.E.	Cloudy		8 a.m.
	12 noon	30.0	55.58	56.34	51.80	S.E.	Rain		12 noon
	8 p.m.	30.0	61.90	54.50	50.0	W.	Clear		8 p.m.
,, 27	8 a.m.	30.1	54.68	53.24	50.90	W.	Cloudy		8 a.m.

OBSERVATIONS TAKEN BY THE EXPEDITION

MERCURIAL BAROMETER.		Mean Temperature of the Air.	THERMOMETER.		HYGROMETER.		Wind.	Sky.	Atmosphere.	Altitude.
Readings.	Temperature.		Maximum.	Minimum.	Hundredths of Saturation.	Temperature.				
25.2	46.40	42.80	—	—	39.0	46.40	S.W. 1	Stratus 3	—	
25.2	39.20	36.50	—	—	48.0	39.20	—	—	Sultry	5,082
25.2	32.36	31.46	—	—	78.0	32.0	—	Stratus 5	Low fog	
25.2	39.20	40.30	—	—	—	—	—	—	—	
—	—	—	—	—	—	—	—	—	—	
24.4	31.64	32.18	—	—	84.0	32.18	—	Cloudy	Thick fog	
24.1	34.70	32.54	34.34	27.68	71.0	36.14	—	Cloudy	Fog—Snow	
24.0	38.22	35.24	41.0	27.50	79.0	37.04	—	Cloudy	Fog—Snow	
23.11	32.36	33.98	—	—	84.0	33.08	—	Cloudy	Fog—Snow	
23.10	38.84	36.32	41.18	29.84	69.0	41.0	—	Cloudy	Fog—Snow	
23.10	47.30	43.86	—	—	45.0	55.40	—	Cloudy	Snow	
23.10	31.10	30.56	51.80	28.20	85.0	30.92	—	Cloudy	Snow (1)	5,754
23.11	42.80	39.38	21.44	29.30	46.0	50.0	—	Cloudy	—	
24.0	46.40	42.80	55.40	37.04	27.0	55.40	N.E. 1	—	—	
23.11	31.10	30.56	55.40	27.50	81.0	30.02	N. 1	Cirro-Cumulus 4	Thin fog	
24.0	35.96	33.44	—	—	69.0	37.04	—	—	Snow	
24.0	39.20	37.06	47.30	35.60	52.0	41.0	—	—	—	
24.0	37.40	35.96	—	—	62.0	39.20	—	—	—	
(2)	—	29.66	—	—	80.0	32.0	—	—	—	
—	—	37.76	42.80	25.34	52.0	42.80	—	—	Snow	
—	—	—	—	—	—	—	—	—	—	
	—	28.76	36.32	24.80	88.0	28.04	N.W. 2	—	—	6,460
—	—	28.94	44.60	26.60	40.0	39.20	—	Cirro-Stratus 4	Foggy	
—	—	33.44	72.50	24.80	25.0	35.04	—	—	Snow (3)	
—	—	24.44	60.80	21.20	80.0	24.08	—	—	—	
—	—	35.60	65.84	21.20	37.0	37.04	—	—	—	

DATE.	OBSERVATIONS TAKEN BY REV. HENDRIKSEN AT THE MISSION OF YAKUTAT (24 feet above the level of the sea).								
	Hour.	MERCURIAL BAROMETER.		PSYCHRO-METER.		Wind.	Sky and Atmosphere.	Locality.	Hour.
		Readings.	Temperature.	Dry Thermometer.	Wet Thermometer.				
July 27	12 noon	30.1	59.0	53.60	52.70	—	Cloudy	**20th Camp** On the Newton Glacier, third ice-fall.	2.30 p.m.
	8 p.m.	30.2	56.66	55.40	51.80	—	Cloudy		8 p.m.
,, 28	8 a.m.	30.2	56.84	54.50	52.34	—	Foggy		8 a.m.
	12 noon	30.2	58.10	53.60	51.80	—	Foggy		12 noon
	8 p.m.	30.2	56.30	54.50	50.0	—	Rain	— —	8 p.m.
,, 29	8 a.m.	30.1	56.48	57.14	50.0	—	Cloudy	— —	—
	12 noon	30.0	58.28	54.50	52.70	—	Clear	**21st Camp** On the Newton Glacier, high plateau.	12 noon
	8 p.m.	30.0	50.08	57.14	52.34	—	Clear		—
,, 30	8 a.m.	30 0	52.88	49.10	47.30	—	Cloudy	— —	—
	12 noon	30.0	56.48	53.60	52.34	—	Clear	**22nd Camp** Russell Col	12 noon
	8 p.m.	30.1	59.90	56.84	54.50	—	Clear		8 p.m.
,, 31	8 a.m.	30.3	55.40	54.50	53.60	—	Foggy	**Climbing the N.N.E. ridge**	8 a.m.
	12 noon	30.4	58.28	53.60	53.60	W.	Cloudy	**On the Summit of Mount St. Elias**	12 noon
	8 p.m.	30.4	55.40	56.30	51.80	N.	Cloudy	**22nd Camp** Russell Col.	8 p.m.
Aug. 1	8 a.m.	30.4	56.30	54.50	53.60	E.	Rain		8 a.m.
	12 noon	30.4	56.48	54.50	52.70	N.	Foggy	— —	—
	8 p.m.	30.3	58.28	55.94	52.70	—	Foggy	**21st Camp** Newton Glacier, high plateau.	8 p.m.
,, 2	8 a.m.	30.2	54.68	51.84	50.90	—	Foggy		—
	12 noon	30.1	56.48	56.30	56.30	—	Foggy		12 noon
	8 p.m.	30.1	58.28	56.30	52.70	—	Rain		8 p.m.
,, 3	8 a.m.	30.0	56.48	56.48	56.30	—	Rain		8 a.m.

(1) In 12 hours it snowed 30 inches. The aneroids foretold very regularly the weather, giving a minimum pression (23.7) the 22nd of July, at 10 o'clock a.m.

OBSERVATIONS TAKEN BY THE EXPEDITION.

RCURIAL ROMETER.		Mean Temperature of the Air.	THERMOMETER.		HYGROMETER.		Wind.	Sky.	Atmosphere.	Altitude.
ad-s.	Temperature.		Maximum.	Minimum.	Hundredths of Saturation.	Temperature.				
)	—	37.76	—	—	—	—	—	—	—	
.	—	30.20	—	24.24	62.0	29.48	N.W. 2	Cirro-Stratus 3	—	
.	—	41.0	62.80	23.0	59.0	28.04	—	Cirrus 3	Dark	7,431
.	—	42.80	—	21.20	52.0	28.04	E. 3	Cloudy	Snow	
.	—	—	—	—	—	—	N.W. 1	Clear	—	
-	—	—	—	—	—	—	—	—	—	
11	41.0	40.10	—	—	—	—	N.W. 1	Clear	—	8,661
-	—	—	—	—	—	—	—	—	—	
-	—	—	—	—	—	—	—	—	—	
11	33.80	32.0	—	—	25.0	33.80	—	—	—	12,297
11	18.50	18.50	33.80	18.50	23.0	19.40	—	—	—	
2	21.20	16.88	—	—	—	—	—	—	—	16,509
2	**11.20**	**10.40**	—	—	**30.0**	**25.98**	—	**Clear**	**Clear**	**18,090**
o	18.70	15.80	—	—	47.0	18.50	—	—	—	12,297
o	24.80	21.0	—	14.0	28.0	24.08	—	—	—	
	—	—	—	—	—	—	—	—	—	
10	21.0	23.90	—	—	79.0	25.88	—	—	—	
	—	—	—	—	—	—	—	—	—	8,661
11	62.60	53.60	—	—	48.0	53.60	—	Clear	—	
	—	35.60	—	—	—	—	—	—	—	
	—	42.80	44.60	24.80	54.0	42.80	—	Cloudy	—	

(2) Gay-Lussac barometer broken. The Fortin barometer (from 10 to 22 inches) is not working yet.
(3) In 12 hours it snowed 32 inches.

COMPASS BEARINGS (PRISMATIC COMPASS).

30th of July. *From Russell Col.*

Mount	St. Elias	182°
,,	Newton	31°30′
,,	Vancouver	58°
,,	Augusta	61°
,,	Hubbard	69°
,,	Cook	75°
,,	Fairweather	101°

31st of July. *From the top of Mount St. Elias.*

Mount	Logan	13°
,,	Vancouver	54°
,,	Cook	73°45′
,,	Bona	311°
,,	Bear	326°
,,	Lucania	348°

COMPARISON OF THE ANEROID (SIMMS, NO. 1486) AGAINST THE MERCURIAL BAROMETER.

One of the three aneroids with which the expedition was provided was spoilt at an early stage of the ascent, and the pocket aneroid became useless shortly above the height of 9,000 feet. The Simms aneroid (No. 1486) that was taken to the summit of Mount St. Elias always gave excellent readings, which are considered to be worthy of record. A rectifying table both for this and the other aneroids had been drawn up for us by Mr. W. T. Hammer, Director of the United States "Weather Bureau" of San Francisco. Frequent comparisons made with the mercurial barometer in the month of June and first half of July rendered it advisable to always make an alteration of −·236 inch to the corrections given in the table; which alteration proved to be entirely justified by the comparisons afterwards made.

Accordingly, a fourth column was added to the table of the San Francisco Meteorological Office, containing, correspondently with the different pressures, the medium figures of corrections ascertained by the said office, with −·236 inch in addition. These additional corrections are applied to the pressures read from the aneroid.

On comparing the corrected pressures thus obtained with those given at the same moment by the mercurial barometer, it is seen that the error caused by relying solely on observations from this well-regulated aneroid would have seldom amounted to −·04 of an inch; which, even at the unusual altitude of 18,000 feet, would only lead, with $(t+t)<(+20°)$, to a difference of less than 100 feet. And this error would be diminished even more if, in calculating the table of corrections, one could take into account the influence of great differences of temperature on the aneroid. This correction according to temperature could not even be attempted, owing to lack of time, and the considerable difficulties in the way of the practical execution of the task. Even the small pocket aneroid was most valuable, owing to the accuracy of its indications and remarkable sensitiveness. But the results recorded from it are not worth publishing, since, having failed us at 9,000 feet, they refer to the least important part of the journey, and offer no fund of observation of any special interest.

From the brief trial made on this climb, it would seem that for ordinary measurement of altitudes, in different ascents, a good, modern, properly rectified aneroid might perfectly take the place of a mercurial barometer, with the great advantage of being lighter, less fragile, and of a more portable shape.

CORRECTIONS TO SCALE READINGS OF SIMMS' ANEROID, No. 1486.

Readings.	Correction obtained by increasing of one inch the pression in one and a half minutes.	Correction obtained by diminishing of one inch the pression in three minutes.	Mean correction.	Correction obtained by adding −.236 of an inch to the mean correction.
30.157	− 0.118	− 0.315	− 0.216	− 0.452
29.134	− 0.157	− 0.315	− 0.236	− 0.472
28.149	− 0.197	− 0.315	− 0.256	− 0.492
27.165	− 0.209	− 0.354	− 0.281	− 0.517
26.181	− 0.236	− 0.354	− 0.295	− 0.531
25.197	− 0.248	− 0.405	− 0.326	− 0.562
24.212	− 0.275	− 0.433	− 0.354	− 0.590
23.228	− 0.335	− 0.472	− 0.403	− 0.639
22.244	− 0.335	− 0.524	− 0.429	− 0.665
21.260	− 0.370	− 0.528	− 0.449	− 0.685
20.275	− 0.366	− 0.559	− 0.462	− 0.698
19.291	− 0.508	− 0.524	− 0.516	− 0.752
18.307	− 0.543	− 0.617	− 0.580	− 0.816
17.323	− 0.531	− 0.692	− 0.611	− 0.847
16.535	− 0.637	− 0.642	− 0.639	− 0.875
15.551		− 0.665	− 0.665	− 0.901

Comparison of Simms' Aneroid, No. 1486, against the Fortin Mercurial Barometer.

Date.	Hour.	Altitude.	Readings of the Fortin Barometer reduced to 32° Fahr.	Simms' Aneroid, No. 1486. Readings.	Readings rectified.	Temperature.	Differences of the Readings.
June 24	8.30 a.m.	5	30.027	30.493	30.043	—	+ 0.016
	1 p.m.		29.976	30.472	30.023	60.80	+ 0.047
	8 p.m.		29.988	30.468	30.004	52.16	+ 0.016
,, 25	8 a.m.		29.964	30.453	30.0	50.18	+ 0.036
	12 noon		29.960	30.394	29.941	53.96	− 0.019
	8 p.m.	47	29.894	30.354	29.901	48.20	+ 0.007
,, 26	8 a.m.		29.878	30.354	29.901	52.70	+ 0.023
	12 noon		29.846	30.354	29.901	—	+ 0.055
	8 p.m.		29.821	30.315	29.862	—	+ 0.041
,, 27	8.30 a.m.		29.858	30.334	29.882	56.30	+ 0.024
	2 p.m.		29.862	30.362	29.909	61.70	+ 0.037
	8 p.m.		29.838	30.334	29.882	53.60	+ 0.044
,, 28	8 a.m.		29.890	30.362	29.909	51.80	+ 0.019
	12 noon		29.874	30.334	29.882	53.60	+ 0.008
	8 p.m.		29.846	30.319	29.866	53.24	+ 0.020
,, 29	8 p.m.	512	29.252	29.716	29.252	37.40	0
,, 30	8 a.m.	551	29.118	29.622	29.104	—	− 0.014
	8 p.m.		28.964	29.468	29.0	40.64	+ 0.036
July 1	12 noon	1007	28.315	28.842	28.362	44.60	+ 0.047
	8 p.m.		28.366	28.878	28.397	41.0	+ 0.031
,, 2	2.30 p.m.	1417	28.224	28.720	28.240	42.80	+ 0.016
	8 p.m.		28.232	28.748	28.268	37.94	+ 0.036

Date.	Hour.	Altitude.	Readings of the Fortin Barometer reduced to 32° Fahr.	SIMMS' ANEROID, No. 1486. Readings.	Readings rectified.	Temperature.	Differences of the Readings.
July 3	8 p.m.	1703	28.177	28.693	28.212	38.30	+ 0.035
,, 4	8 a.m.		28.220	28.911	28.237	44.60	+ 0.017
	8 p.m.		28.201	28.904	28.224	—	+ 0.023
,, 5	8 p.m.	2162	27.775	28.303	27.803	—	+ 0.028
,, 6	8 p.m.	2454	27.496	28.031	27.531	36.50	+ 0.035
,, 7	8 a.m.		27.484	28.016	27.516	44.0	+ 0.032
	12 noon		27.453	27.988	27.488	69.0	+ 0.035
	8 p.m.		27.433	27.952	27.453	—	+ 0.020
,, 8	12 noon	2979	26.913	27.441	26.941	—	+ 0.028
	8 p.m.		26.972	27.500	27.0	47.30	+ 0.028
,, 9	8 p.m.	3261	26.622	27.165	26.653	—	+ 0.033
,, 10	8 p.m.	3714	26.149	26.673	26.153	—	+ 0.004
,, 11	8 a.m.		26.031	26.575	26.051	—	+ 0.020
	8 p.m.		25.972	26.535	26.008	—	+ 0.036
,, 12	8 a.m.		25.858	25.496	25.968	—	+ 0.110
	12 noon		25.937	25.496	25.968	—	+ 0.031
	8 p.m.	4682	25.583	26.149	25.618	39.92	+ 0.035
,, 13	8 a.m.		25.374	25.964	25.429	48.20	+ 0.055
	12 noon		25.421	25.992	25.453	59.0	+ 0.032
	8 p.m.	3566	25.799	26.567	26.043	—	+ 0.224
,, 14	8 a.m.		25.996	26.543	26.016	—	+ 0.020
	12 noon		26.043	26.583	26.055	41.0	+ 0.012
	8 p.m.		26.086	26.634	26.114	41.0	+ 0.028
,, 15	8 a.m.		26.070	26.634	26.114	42.80	+ 0.044
	12 noon		26.173	26.732	26.209	51.80	+ 0.036

Date.	Hour.	Altitude.	Readings of the Fortin Barometer reduced to 32° Fahr.	SIMMS' ANEROID, No. 1486.			Differences of the Readings.
				Readings.	Readings rectified.	Temperature.	
July 15	8 p.m.	3740	26.0	26.555	26.031	—	+ 0.031
„ 16	8 p.m.		25.542	26.114	25.575	36.40	+ 0.033
„ 17	8 a.m.		25.579	26.122	25.583	33.80	+ 0.004
	12 noon		25.563	26.102	25.567	40.10	+ 0.004
	8 p.m.	4485	25.460	25.996	25.460	38.84	0
„ 18	8 a.m.		25.370	24.945	25.405	44.60	+ 0.035
	12 noon		25.421	25.984	25.449	48.20	+ 0.028
	8 p.m.		25.517	26.063	25.528	35.60	+ 0.011
„ 19	7.30 a.m.		25.665	26.228	25.697	41.0	+ 0.032
	4 p.m.		25.197	25.783	25.240	38.84	+ 0.043
	6 p.m.	5082	25.185	25.748	25.205	35.60	+ 0.020
	8 p.m.		25.169	25.728	25.185	28.40	+ 0.016
„ 20	8 p.m.		24.409	25.004	24.437	33.80	+ 0.028
„ 21	8 a.m.		24.134	24.724	24.149	33.80	+ 0.015
	12 noon		24.067	24.677	24.098	34.16	+ 0.038
	8 p.m.		23.968	24.567	23.988	36.50	+ 0.020
„ 22	8 a.m.		23.874	24.468	23.890	36.50	+ 0.016
	12 noon		23.878	24.480	23.901	47.30	+ 0.023
	8 p.m.	5754	23.874	24.484	23.905	34.70	+ 0.031
„ 23	8 a.m.		23.897	24.488	23.909	43.70	+ 0.012
	12 noon		23.968	24.567	23.988	55.40	+ 0.020
	8 p.m.		23.992	24.606	24.027	39.20	+ 0.035
„ 24	8 a.m.		24.020	24.606	24.027	36.84	+ 0.007
	12 noon		23.992	24.598	24.020	35.60	+ 0.028
	8 p.m.		24.008	24.606	24.031	39.20	+ 0.023

Date.	Hour.	Altitude.	Readings of the Fortin Barometer reduced to 32° Fahr.	SIMMS' ANEROID, No. 1486.			Differences of the Readings.
				Readings.	Readings rectified.	Temperature.	
July 25	8 a.m.		—	23.945	23.374	41.0	—
	8 p.m.		—	24.023	23.425	44.60	—
,, 26	8 a.m.	6460	—	24.153	23.559	40.64	—
	12 noon		—	24.130	23.535	50.0	—
	8 p.m.		—	24.137	23.551	33.80	—
,, 27	8 a.m.		—	24.193	23.602	39.20	—
	8 p.m.		—	23.547	22.913	41.0	—
,, 28	8 a.m.	7431	—	23.464	22.831	36.50	—
	12 noon		—	23.583	22.949	35.78	—
,, 29	12 noon	8661	21.809	22.598	21.941	41.0	+ 0.032
,, 30	12 noon	12297	18.968	19.673	18.949	33.80	− 0.019
,, 31	8 a.m.	16509	16.279	17.067	16.272	19.40	− 0.007
	12 noon	18090	15.204	16.063	15.177	15.80	− 0.027
	8 p.m.	12297	19.083	20.472	19.031	23.0	− 0.052
August 1	8 a.m.		19.094	19.811	19.086	24.80	− 0.008
	8 p.m.	8661	21.929	22.590	21.913	32.0	− 0.016
,, 2	12 noon		21.909	22.563	21.901	15.80	− 0.008

APPENDIX C

Medical Notes

OUR medical outfit comprised the following items:—

1. A small medical chest containing an assortment of compressed tabloids and soloids. Also, one small box of ophthalmic tabloids, one of drugs for subcutaneous injections, some tubes of lanoline, powders for curing snow-dermatitis, a few tubes of ethyl-chloride for local anæsthesia during slight operations, and other medicaments of secondary importance.
2. A surgical case stocked with the indispensable instruments for use in emergencies, and to supply "first aid" at least, in case of any bad accident.
3. Packets of compressed aseptic dressings, in three different sizes, each containing one complete dressing.[1]
4. A piece of stout canvas to be used as a stretcher by slipping a couple of sticks through the hems at the edges.

A supply of surgical appliances was left at the coast; the rest of the sanitary outfit, weighing 36 lbs., was carried up as far as Sledge Camp at the base of Newton Glacier. Above that point, the expedition was only provided with one small leather case of drugs, one of surgical instruments, and a few packets of dressings.

No accidents occurred throughout the journey, and the whole caravan enjoyed excellent health, with the exception of certain slight ailments to be specified later on.

A noteworthy fact is the comparative immunity from so-called rheumatic diseases which is peculiar to life on glaciers, although exceptionally exposed to all the conditions apparently most conducive to those complaints. Here were twenty-one men, living among snow and ice for many weeks in the dampest of climates, only sheltered under canvas for a few hours at night, coming into camp late, soaked to the skin after long tramps through melting snow or pouring rain, often unable to obtain dry flannels for the night, enduring the severest fatigue; yet not one of the number suffered in the least from either muscular or articular rheumatism, nor from bronchial catarrh, even in its mildest form of ordinary cold in the head.

[1] The medicine chest was provided by the firm of Burroughs, Wellcome & Co. (London); the surgical case by E. Bergamini (Bologna); and the dressings by C. Rognone (Turin).

Mr. Russell's experience was equally fortunate, for during both his expeditions to the same region there was no case of illness in his party, although his means of protection against the climate were less efficient than ours.[1]

Our system of diet answered perfectly with us all, and no one suffered from any disturbance of the digestive organs.

On the other hand, we had a few slight cases of snow-blindness, although we seldom neglected the use of smoked spectacles. The sufferers were all quickly cured by applications of cocaine and by avoiding for some days undue exposure to the glare of the snow. In this connection let me add that expeditions equipped to remain some time in glacier regions should be provided with a few pairs of very dark snow-spectacles, so that any one suffering from slight ophthalmia may continue the march without great injury. We made shift to lessen this evil by smoking the glasses with a lighted candle or match.

We had no case of erythema of the face or hands requiring more than ordinary care, perhaps because most of our time was spent at only a moderate height above the level of the sea. It is well known that the skin and eye troubles often produced by glacier ascents are now attributed to the fact that, at great altitudes, light contains more ultra-violet rays than in lower strata of the atmosphere.

The single case of illness that occurred during the campaign was a malarial infection of the tertian fever type, with which a young American porter was seized on the Malaspina Glacier, almost at the end of our journey, in descending to the coast. This case is rather interesting as regards the geographical distribution of malaria.

On the night of the 8th–9th August this porter had slept with his comrades on a little grassy plateau of the Hitchcock Hills. Thence he and the others made their way down to the Malaspina Glacier, across the muddy bed of the glacial lake formerly spreading at the base of the chain, but which had run dry two months previously. On the evening of the 9th of August we encamped on the Malaspina Glacier. Next day the porter was seized with fever, about 4 o'clock p.m., after preliminary fits of shivering; his temperature rose to between 103° and 104° Fahr., but went down to normal during the night, with profuse perspiration. After two more attacks of the same description on alternate days, the fever was cut short by doses of chlorhydrate of quinine. It was the first time in his life that he had suffered from malarial poison.

In describing the hygienic conditions of an Alaskan expedition, mention must be made of the mosquitoes infesting the whole of the coast-zone. It is no exaggeration to say that they must prove a serious obstacle to any

[1] The illness of one of Mr. Bryant's men (*vide* chap. vii. p. 131) seems to have been caused by an intestinal malady, probably contracted before he started on the expedition.

expedition compelled to remain long in the wooded region. I do not know of any adequate defence against this scourge. The specially prepared ointments, veils, and nets with which we were provided proved totally inefficient; not even by smoking and sitting close to the fire could we escape their attacks. In June and July they are rather less troublesome; but a single August night in the forest is enough to disfigure the traveller. His face becomes a mass of puffy lumps, while his eyelids are often so swollen that the eyes are entirely closed. A small drop of blood exudes from every spot stung. The swelling lasts for some days after the intolerable irritation has ceased.

I subjoin Petroff's vivid description of this plague of Alaska, and can vouch for its fidelity.

"There is a feature in this country which, though insignificant on paper, is to the traveller the most terrible and poignant affliction he can be called upon to bear in a new land. I refer to the clouds of bloodthirsty mosquitoes, accompanied by a vindictive ally in the shape of a small, poisonous black fly, under the stress of whose persecution the strongest man with the firmest will must either yield to exhaustion or succumb to low fever. They hold their carnival of human torment from the first burst of spring vegetation in May until it is withered by frosts late in September. Breeding in the vast ponds and marshes, of which Alaska is full, they gather around the explorer and harass his camps and his marches beyond all power of adequate description, and language is simply unable to pourtray the misery and annoyance accompanying their presence. It will naturally be asked, How do the natives bear this? They too are annoyed and suffer, but it should be borne in mind that their bodies are anointed with rancid oil; and certain ammoniacal vapours, peculiar to their garments from constant wear, have a repellent power which even the mosquitoes, bloodthirsty and cruel as they are, are hardly equal to meeting. When travelling, the natives are, however, glad enough to seize upon any piece of mosquito-net, no matter how small, and usually they have to wrap clothes or skins about their heads and wear mittens in midsummer. The traveller who exposes his bare eyes or face soon loses his natural appearance; his eyelids swell up and close, and his face becomes one mass of lumps and fiery pimples. Mosquitoes torture the Indian dogs to death, especially when by mange or old age they lose any considerable portion of their coat. Even the bear and the deer they drive into the water." [1]

The greater part of the expedition was in a region of moderate altitude at less than 6,000 feet above the sea; the American porters only mounted as far as the third cascade of the Newton Glacier (7,431 feet); H.R.H., our-

[1] Petroff, *Population, Industries and Resources of Alaska*, 1884. This report is quoted in *Alaska*, a handbook published by the "Bureau of the American Republics," No. 84, August, 1887, p. 28.

selves, and the guides passed only two nights at a height of 12,297 feet, on the Russell Col, only spent a few hours above 16,000 feet, and conditions were then too unfavourable for us to be able to collect any important facts to enlarge our knowledge of mountain sickness.

Professor Angelo Mosso, whose work on *The Physiology of Man on the Alps* [1] contains so rich a store of accurate observations and genial experiences, throwing much light on the difficult problem of mountain sickness, states that it is absolutely necessary to observe and note down the symptoms of the malady in particular conditions, in order to distinguish the effects of diminished atmospherical pressure from those produced by cold and fatigue. Without such distinction, notes are of no value. It is perhaps needless to add that the observer should be calm and free from anxiety. Violent external impressions, or intense inward excitement not bearing upon the subject at hand, are fatal to an exact inquiry into and a severe critical analysis of facts.

Accordingly, I can only offer a few brief notes on mountain sickness, without venturing to deduce any conclusion, or to establish their connection with any of the numerous theories which have been suggested in explanation of that curious complaint.

As I have already said in describing the ascent, six of us out of the ten were more or less acutely affected by the diminished pressure of the air, three of us rather severely. The proportion of those attacked was certainly unusual when it is considered that, Lieut. Cagni excepted, we were all acclimatized to high levels by repeated Alpine ascents to altitudes above 14,000 feet, and that Mount St. Elias is much lower than the heights attained by other climbers, who as a rule have begun to suffer distress at from 19,000 to 20,000 feet.

The history of Alpine climbing records the ascents made in Nepaul by the brothers Schlagintweit between 1854 and 1856, when they reached the height of 22,239 feet; E. Whymper's ascent of Chimborazo (20,545 feet), in 1880; Sir Martin Conway's ascent of the Pioneer's Peak in the Indian Kara Korum chain (23,000 feet), in 1892; the ascent of Aconcagua (23,080 feet) by J. S. Vines, of E. A. FitzGerald's expedition, in 1897; together with Sir Martin Conway's two ascents, in 1898, of the Illimani and Sorata peaks, respectively 22,500 and 21,710 feet above the sea.

It seems to me that the attacks of mountain sickness experienced by our party were chiefly caused by our long and difficult marches over snow and ice, and the weeks of over-fatigue and discomfort we had gone through before reaching the base of the huge pyramid. In all the high ascents to which I have referred, the possibility of riding part of the way up led to an enormous economy of effort and considerable increase of comfort. The Newton Glacier had been climbed under particularly fatiguing conditions, laden as we were with heavy loads, and sinking as we did continually more

[1] A. Mosso, *La Fisiologia dell' Uomo Sulle Alpi.* Milano, 1898, 2nd edn.

than knee-deep in the snow. On the day before the final ascent, we had climbed more than 3,000 feet from the Newton basin to Russell Col ; and at night, huddled together five in a tent, suffering from the cold, and very excited by our nearness to the goal, few of us were able to sleep. On page 247 of Mosso's book, a fact is noted that proves the influence of fatigue in producing mountain sickness. It seems that the miners engaged in blasting a level space on the Gnifetti peak of Monte Rosa for the erection of the Regina Margherita hut, only began to feel the effects of the diminished pressure when tired out by several days' work.

The general conditions of Mount St. Elias were not especially conducive to mountain sickness. Slow and monotonous as was the climb, the excitement of the attainment should have been sufficient compensation for the tediousness of the ascent. The temperature was very favourable, the cold not excessive (17·6° to 10° Fahr.), there was a briskness in the air, without wind, and the whole way lay along a ridge in full view of a superb panorama.

As to the symptoms we experienced, having only subjective sensations to record, I will briefly relate what happened to myself.

I was the first to be attacked with mountain sickness. At a height of between 14,700 and 15,700 feet, on starting afresh after a short rest, I suddenly felt my legs as heavy as lead, a difficulty in breathing, a sense of suffocation, palpitations, throbbing of the temples and headache, with the sensation of having a tight band round the brows. Without feeling actual nausea, I could neither eat nor drink, and took absolutely nothing the whole day, until we had descended to the *col*. However, I did not suffer from thirst. I was aware of no disturbance of the power of vision, and had no buzzing in the ears.

When we halted, I found it easier to rest standing; after involuntarily drawing four or five deep breaths, my breathing soon became more normal. One seemingly paradoxical fact I should hesitate to mention were it not supported by a remark in Mosso's book (p. 141), namely, that smoking a cigarette while at rest aided me to breathe more regularly, and was also the best means of combating the heavy somnolence which came over me whenever I came to a standstill.

Short halts rested me better than long ones. On starting afresh, I always found the first steps the most difficult, either from the stiffening of the muscles, or because the interval of rest had suspended automatic action of the muscles and made necessary the conscious intervention of the will-power. I remember that I tried to step in time as regularly as possible, and I believe this assists the return of the unconscious muscular action. As I went on, walking gradually became easier, while breathing became more difficult, and the sense of oppression returned.

All these symptoms went on increasing in intensity up to an altitude of 16,000 feet ; but then slowly, as we mounted higher, they began to diminish. Thus, although physical fatigue may act as the predisposing cause of mountain sickness, later on its most important factor is, certainly, the diminished pressure of the atmosphere; and besides, even in the short time employed on an ascent, it is possible to become so sufficiently adapted to new conditions, as to suffer less from mountain sickness while still climbing upwards. Cagni was seized with the malady at a higher point than myself, namely, at over 16,000 feet, and Sella's assistant photographer, Botta, only at a height of about 17,500 feet. But on reaching the summit, Botta was in a worse state than any of us, and I, who had been the first victim, suffered less than the two others, and was the first to recover. I am certain that all of us could have mounted higher; and perhaps the two others who suffered to the same extent as myself might have experienced the same gradual adaptation to existing circumstances that proved the case with me.

On winning the summit we were all overcome with excitement for some minutes, and shouted so heartily that no one could have been said to lack breath. Then, most of us fell into a state of passive, apathetic indifference. I remember that H.R.H. was obliged to shake us in order to induce us to take meteorological observations and study the features of the country. But excepting this curious dulness and aversion to food, no other symptoms remained. We merely suffered somewhat from cold.

During the descent I walked well, without any feeling of over-fatigue or difficulty of breathing; but the headache continued for some time, and only disappeared when we were below 13,000 feet, owing possibly to the rapidity of our descent. We were all perfectly well by the time we got down to the *col*, and by no means too tired to eat a hearty supper.

One phenomenon frequently noticed in mountain ascents, loss of memory, was markedly felt by us all. The following day, when we began to write our impressions of the climb, we all found strange gaps in our recollections, and had to appeal to one another to help to fill them in. The narrative of the ascent, as given in chapter viii., is gleaned from the reminiscences of the whole party. Possibly no single one of us could have recalled all the particulars of the ascent or the details of the vast landscape.

In conclusion, I may mention one circumstance tending to prove that the conditions of Mount St. Elias conduce to the development of mountain sickness. Our guide, Antoine Maquignaz, had a decided, though slight attack of the malady on St. Elias; yet when climbing Mounts Illimani and Sorata in the Central Andes with Sir Martin Conway, he not only ascended to a height of 22,500 feet, but while at 20,000 feet was able to share with his comrade, Louis Pellissier, the hard labour of cutting steps in frozen snow and of dragging a heavy sledge over steep snow-slopes.[1] I do not believe he could have done much work of the same kind on Mount St. Elias, 2,000 feet lower down.

[1] Sir Martin Conway, "My Climbs in the Andes in 1898" (The *Alpine Journal*, August, 1899).

APPENDIX D

Animals collected during the Expedition

I RECEIVED from Dr. De Filippi the few animals brought by the expedition; they are all from the Malaspina Glacier, and were found on the snow; they belong to five species.

Two are flying insects which came accidentally on the glacier, perhaps from a great distance; they are—one Dipteron, *Syrphus arcuatus*, Fallen, a common species in Europe and North America, as Dr. Giglio Tos, of Turin, who had the kindness to identify it, writes me, and an Hymenopteron, *Ichneumon hiemalis*, Cress., which was identified by Dr. J. Kriechbaumer, of the Museum of Munich.

The three other species belong doubtless to the proper fauna of the glacier, viz.: a springtail of the genus *Isotoma*, nearly related if not identical with *I. Besselsi*, Pack.[1]; an Arachnid of the Opilionid order, on which Prof. Pavesi has established a new genus and a new species under the name *Tomicomerus bispinosus*; an Oligochætous Annelid, which forms also a new genus and which I have described as *Melanenchytraeus solifugus*.

C. EMERY.

ON *ICHNEUMON HIEMALIS*, CRESS.

By Dr. JOSEPH KRIECHBAUMER.

This species is described by Cresson, from a female specimen from the Aleutian Islands. Dr. Kriechbaumer, considering the original diagnosis to be insufficient, has made the following description of the specimen from the Malaspina Glacier:—

Ichneumon hiemalus (recte **hiemalis**) Cresson.

Proc. Cal. Acad. 1877 (sec. cit. seq.)
Trans. Amer. Ent. Soc. 1877, p. 181, n. 180, ♀.

♀ Niger, capite, dimidio fere basali antennarum, mesonoto, abdomine, pedibusque (coxis posterioribus exceptis) rufis, antennis filiformibus, involutis, postpetiolo subtilissime aciculato, gastracoelis majusculis, obliquis,

[1] I sent this insect to Prof. Grassi for determination; he committed the study of it to his assistant, Dr. Silvestri, who soon after set out for South America, leaving this work unachieved.

terebra vix exserta, alis hyalinis, stigmate fulvo, areola pentagona, subirregulari. Long. 10 mm.

Caput transversum, subtiliter punctatum, genis longis, rectis, clipeo a facie indistincte discreto, apice truncato, labro parum exserto, utrinque acuminato. Antennae filiformes, modice longae et crassae, post mortem involutae. Mesonotum planiusculum, subtiliter punctulato-rugulosum ; scutellum truncato-triangulare, planiusculum, basi fere levi, apice rugulosum ; metanotum rotundatum, distincte areolatum, area supero-media semiovali subhexagona, majuscula, basin fere attingente, areis supero-lateralibus inter se vix discretis, anteriore transversa, rectangulari, posteriore triangularia, area posteromedia magna, subhexagona, infra costulis aliquot abbreviatis parum distinctis, areis postero-lateralibus costa interna bene discreta, externa plana obsoleta. Abdomen lanceolato-ovatum, planiusculum, subtilissime punctulatum, petiolo modice longo et lato, levi, nitido, polito, arcuatim in postpetiolum quadruplo latiorem dilatato, hoc subtilissime aciculato ; segmento secundo longitudine vix, reliquis ea distincte latioribus. Alarum areolae nervulo postico extra medium fracto. Color ut in diagnosi indicatus.

J. Kriechbaumer.

A NEW AMERICAN NEMASTOMID.

By Prof. Pietro Pavesi.

My friend Prof. Emery affords me the opportunity of examining three specimens of an Arachnid discovered by Dr. De Filippi on the snows of Mount St Elias, during the journey of H.R.H. the Duca degli Abruzzi in Alaska.

The Arachnological fauna of that region is nearly unknown. So far as I am aware, spiders have been published from the peninsula and neighbouring islands only ; they present the types common to the boreal zone of America and Eurasia, the characteristically small number of species, the prevalence of the smaller sorts ; they are described by Keyserling [1] on the Marx collection in papers not cited by Simon,[2] in his bibliography for the study of Arctic Arachnids.

Two are Tomisidae of Alaska proper, *Xysticus borealis* and *Philodromus alascentis*, Keys. ; the others are Therididae : *Erigone polaris*, Keys., from the islet St. Georges, north of Behring's Sea ; *Erigone schumaginensis*, Keys., from the island Schumagin, a little below the point of Alaska ; *Theridium Marxii* and *Satilatlax Marxii*, Keys., *Erigone simillima*, Keys. (= *longipalpis*, Emert. ?), *formica*, Emert., and *vaccrosa*, Keys., from Unalaska in the Fuchs group ; *Erigone umbraticola*, Keys., from Kanaka, another of the Aleutians,

[1] *Neue Spinnen aus Amerika*, V. Wien, 1884 ; *Die Spinnen Amerikas*, Bd. II, I Halfte. Nürnberg, 1886.

[2] *Liste des Arachnides recueillis en 1881, 1884 et 1885, par MM. J. de Guerne et C. Rabot en Laponie.* Paris, 1887.

found again in the island of Sitka, southward of Mount St. Elias, which possesses also the *Linyphia arctica* and *sitkaensis*, Keys., *Pedanostethus lividus* Blkw., *Erigone ululabilis*, *famelica* and *famularis*, Keys.

But the Arachnid of Mount St. Elias is an Opilionid, and restricting ourselves to those, we know from North America only a number of species described by Wood [1] and Weed,[2] four *Phalangodes*, one *Phlegmacera*, and two *Nemastoma*, living in caverns and illustrated by Packard,[3] *Mitopus biceps* by Thorell,[4] and *Taracus Packardii* by Simon,[5] all from the most central provinces of the United States.

If we take into consideration other Arctic regions, we know with certainty the existence of *Oligolophus* or *Mitopus alpinus*, Herbst, in Greenland and Lapland ; of var. of the latter, *borealis*, Thor., as far north as the island Maasoë, near the North Cape ;[6] and of *M. morio*, F., and *Phalangium Nordenskiöldi*, L. Koch (*Opilio funestus*, K.) in Oriental Siberia.[7] A greater number of Opilionids of further Siberia were published by Dr. L. Koch,[8] namely in addition to the two common species above mentioned—*Phalangium cornutum*, L., *capricorne* and *personatum*, L. Koch, *Acantholophus tridens*, C. Koch, and *Nemastoma crassipalpis*, L. Koch.

Doubtless this latter from Nischnij-Jubatsk and Tungusca, as well as *Nemastoma inops* and more certainly *Phlegmacera cavicolens* (the two latter from the Bat-cave in Kentucky) belongs rather to the genus *Taracus*, Simon,[9] of Colorado, or to *Sabacon*, Simon,[10] from the Herault and Lower Pyrenees, judging from the form and direction of the tarsus of the palpus, which in the fig. 19, pl. III., of Koch, and figs. 4*a* and 5*d*, pl. XIV., of Packard appears to be flected downward. But Packard connects his genus *Phlegmacera* with the Phalangiidae, and Simon puts *Taracus* and *Sabacon* near *Ischyropsalis*, C.K.,

[1] *On the Phalangeae of the United States*, Philadelphia, 1868.

[2] *A descriptive Catalogue of the Harvest-spiders* (Phalangidae) *of Ohio*. Washington, 1893. The same has written on the Phalangeae of Illinois and New Hampshire ; but I know these papers only by incomplete citations.

[3] *The Cave-fauna of North America, with remarks on the anatomy of the brain and origin of the blind-species*. Nation. Acad. Sc., IV., 1886. They are from the Mammoth Cave and other caverns of Kentucky, from the Wyandote Cave in Indiana, and from the Clinton in Utah.

[4] *Descriptions of the Araneae collected in Colorado in 1875 by A. S. Packard*. Washington, 1877.

[5] *Descriptions d'Opiliones nouveaux*. Paris, 1879.

[6] THORELL, *Sopra alcuni opilioni d'Europa e dell'Asia occidentale*, Genova, 1876 VAN HASSELT, *Spinnen door Dr. Tenkate jr. in noordiljk Lapland verzameld's*. Gravenhage, 1877 ; SIMON, *Arachnides recueillis en Groënland en 1888 par M. Rabot*. Paris, 1889.

[7] L. KOCH, *Uebersicht der von Dr. Finsch in Westsibirien gesamm. Arachniden*. Wien, 1878 ; SIMON, *Liste des Arachnides recueillis par M. Rabot dans la Sibérie occidentale en 1890*. Paris, 1891.

[8] *Arachniden aus Sibirien und Novaja Semlja eingesamm. von der Schwed. Exped. im Jahre, 1875*. Stockholm, 1869.

[9] Mem. cit., 1879 ; *Les Arachnides de France*, vol. VII. (pag. 277). Paris, 1879.

[10] *Arachn. de France*, vol. cit., pag. 266.

which he separates from the Nemastomidae sensu str., building on these genera a new family.

Packard's view is on the face of it incorrect, as is sufficiently proved by the absence of the hook to the tarsus of the palpus, which is also shorter than the tibia. The opinion of the French entomologist stands in contradiction with the fact that the Alaskan species, whilst it belongs to the Ischyropsalidae by the evident pores or spiracles of the cephalothorax, and is even a *Taracus* by the flat epistoma and the sixth ventral segment, which is free only on the sides, but a *Sabacon* by the ocular tubercle broader than long, and by the shortness of the first article of the mandibles, has however false articulations to the femur and tibia of the foot, a character of *Nemastoma*, C.K. All this would induce us to unite again the family Ischyropsalidae with the old one of Nemastomidae, and may justify the establishment of a new genus; a result by no means surprising.

Tomicomerus [1] n. gen.

Cephalothorax epimeris porisque lateralibus manifestis.
Tuberculum oculorum humile, latius quam longius, leviter canaliculatum.
Epistoma planum.
Mandibulae magnae, articulus primus aeque longus quam cephalothorax.
Palpi corporis longiores; tibia longior quam patella, cylindrica, non incrassata, extremis repente attenuata; tarsus tibia brevior et inferius flexus.
Pedes graciles; femora, praesertim posteriora, tibiaeque articulationibus spuriis praedita.
Segmentum abdominis dorsuale primum reliquis partitum, a cephalothorace cute molli disjunctum; segmenta ventralia sex, sextum anteriori saltem medio coalitum; segmentum anale ovatum.

Sp. typ.: **T. bispinosus** mihi.

Color castaneus testaceo-striolatus, vel pallidus (mas et junior), cephalothorace, partibus oris pedibusque brunneo-nigris, segmentis ventralibus plus minus infuscatis. *Cephalothorax* antice emarginatus, lateribus foveatus, laevis. *Oculi* nigri, ovati, magni, inter se paullulum disjuncti. *Mandibulae* pilosae, articulo primo cylindrico; secundo majore ad basis corniculo verticali obtuso et intus apophisi graciliore praedito; digitis apice decussatis. *Palporum* pars femoralis apicem versus crescens, parum incurvata, pilis brevibus sparsim vestita; pars patellaris teres, longa quam femoralis, densior pilosa et nigerrima, in ♂ tuberculo dentiformi preapicali nigro infra et interius armata; pars tibialis gracilior, peniculo pilorum hirsuta; pars tarsalis dimidio brevior quam tibialis, apice obtuso. *Pedes* sat longi, aequa-

[1] From τομικός = cut, segmented; μηρός = femur. This name would indicate the essential character of the genus if the family Ischyropsalidae were maintained.

liter graciles; coxae ad margines laeves, incrassatae, IV paris longiores et obliquae, pilosae; patellarum quam femorum et tibiarum diametrum majus; femora et tibiae ex aequo, apicem prope dilatata, femur 4–7, tibia 2–4, metatarsis multis, articulationibus spuriis. Segmenta dorsualia *abdominis* polita, primo excepto in medio ad limen anterius, duabus spinulis nigris erectis transversim instructo; segmenta ventralia et anale setosa.

Long. corporis max. 4½ millim.

Hab. mont. S. Eliae (Alaska, America).

From the Laboratorio zoologico della R. Università di Pavia, July 23rd, 1898.

ON *MELANENCHYTRAEUS SOLIFUGUS.*

An Oligochaetous Annelid of the family of the Enchytraeidae.

By Carlo Emery.

In his expedition to Mount St. Elias, J. C. Russell observed on the Malaspina Glacier numerous specimens of a small black worm, which "literally covered" the snow before the rise of the sun, and disappeared beneath the snow as soon as they felt the warmth of the sun rays.[1] Russell states that he never found these worms when the temperature was above freezing point.

The same worms were found again and for the first time collected by Dr. De Filippi, in the conditions described by Russell. They appeared at morning and evening; on foggy days they disappeared later in the morning and re-appeared earlier before sunset; but they were never seen in the hours near mid-day. During the sunny hours, Dr. De Filippi tried digging under the snow to a depth of about fifty centimetres without finding any. In contradiction to Russell's statement, he observed these worms also when the temperature was above freezing point; but during the return journey they were much less numerous, and only on those spots of the glacier which were covered with snow.

The specimens which I have used for this study were put directly in strong alcohol, and are therefore somewhat shrunken; but the state of preservation of the tissues would have allowed a more complete study of the structure of this animal, had the specimens been more numerous,[2] and collected at a more advanced season.

Most of these specimens were immature; they had not developed sperm-ducts or sperm-sacs or spermathecae. In the more mature specimens, the eggs were minute, and I could not recognise any vestige of female genital

[1] *Second Expedition to Mount St. Elias*, Washington, 1894, p. 33. Wright (*The Ice Age of North America*, London, 1890, p. 44) mentions also worms found on a glacier of Alaska and properly on Muir Glacier, "in shallower inclosures of the surface, containing water and a little dirt." The conditions in which they were observed, very different from those in which the worm detected by Russell lives, lead me to think that our worm is not identical to the *Melanenchytraeus* of the Malaspina, but belongs to a different species.

[2] The number of specimens would have been greater, had not a part of the collected material been lost by accident.

ducts ; but one showed a beginning of clitellum development. With few exceptions they were lacking in the organs which are the most important for the discrimination of genera and the determination of affinities in this order of Annelides.

The worm preserved in spirits (Fig. 1) is dark-brown, nearly black. Having bleached a specimen by means of a mixture of chlorate of potassium and hydrochloric acid and mounted it in glycerine, I succeeded in making it sufficiently transparent to count the segments exactly, to observe the bundles of chaetae, and to control by examination of the whole animal some results of the study of microtomic series.

The colour is due to dark pigmentation of the hypodermis (Fig. 7) ; it is so intense that limits of cells or their nuclei are not visible on sections if they are not extremely thin. This fact may depend on the shrinking of the plasm of the epithelium-cells, under the direct action of strong alcohol. In one specimen, unfortunately injured in the genital region, I could recognise the beginning of development of glandular cells in the hypoderm of the twelfth (clitellar) segment (Fig. 8).

In the cephalic lobe, sagittal sections show a well-marked *cephalic pore* (Fig. 3 *pc*) ; in the space between this pore and the mouth the hypoderm is much thickened ; its cells are much elongate, pigmented at their base and apex only. In this region there are in the hypoderm club-shaped bodies, strongly pigmented at their superficial part, nearly pigmentless at their deep or basal part, which shows a large nucleus (Fig. 9 *cs*). I believe that these bodies are *sense cells*, possibly organs of sight ; they seem to be connected with a thick nerve, which arises from the lateral commissure of the œsophageal ring, and distributes itself in that region (Fig. 2). A more accurate study of these supposed sense bodies was not possible on preserved material.

The cutaneous pigment was not confined to the hypoderm ; large cells filled with dark-brown pigment were found around the bundles of chaetae (Figs. 12, 13, 15) and in their neighbourhood. I was not able to recognise the precise nature of these cells ; each of them has a clear round spot showing the nucleus. Brown pigment lies also in the end of the nephridial ducts, near their external opening (Figs. 12, 13).

The *chaetae* are slightly sigmoid, more markedly bent at their apical end (Fig. 10). They are about a third longer in the posterior half of the body than in the anterior segments, as it appears by comparing Figs. 12 and 13. Each bundle consists of four nearly equal chaetae. The ventral bundle is absent in the 12th (clitellar) segment, which receives the opening of the sperm-duct.

The *brain*, as I have made out by graphical construction from a series of sections (Fig. 2), is of nearly quadrate shape, with the anterior margin slightly concave. From the base of each of the lateral commissurae arises the large nerve mentioned above, which distributes to the skin of the cephalic lobe.

In the *mouth*-opening the epithelium is for a short tract pigmented (Fig. 3). Further backward the epithelial cells are pigmentless; but in their interstices we find branched cells, filled with granular brown pigment. In the pharynx, the epithelial cells are very high and hardened at their superficial end, but without a distinct cuticle; between them lie pigmented cells with long branches (Fig. 6).

The *pharynx* builds a dorsal appendage of the œsophagus, in the 2nd and in the beginning of the 3rd segment (Fig. 3 *ph*); its dorsal part gives insertion to a system of muscular bundles, which suspend this organ to the walls of the foremost four body-segments. Fig. 4 gives, in a somewhat schematic form, the graphic reconstruction of these muscles, made from a series of sagittal sections. The system consists of an anterior and posterior group. The former arises from the dorsal wall of the 1st and anterior end of the 2nd segment; the other is more complex and offers two knots, to which the bundles from the dorsal wall of the 3rd and 4th segments, and a bundle from the ventral wall of the 4th, converge.

The part of the alimentary canal which follows on the pharynx, and may be called *œsophagus*, offers no notable widening, and is continuous without partition with the rest of the gut. The long cilia of the intestinal epithelium are clearly shown in my preparations (Fig. 5 *ci*).

I have found in the gut some specimens of an Infusorium of the genus *Anoplophrya* (Fig. 18); I could not see cilia on its surface, although the long cilia were well preserved on the intestinal epithelium in the same section. The intestine of the same specimens of the worm contained a number of ovate, brown bodies, closed in a thin membrane, and filled with clear spherules (Fig. 19 *a*); some of them were cut by the microtome knife (Fig. 19 *b*), and showed in each spherule a grain (the nucleus?), coloured by carmine. I don't know whether these bodies have any relation to the *Anoplophrya*; they might be incapsulated germs of the parasite.

The intestine, and more markedly its posterior part, is filled with very fine crystalline mineral detritus, which seems to be the ordinary food of this worm.

The cells of the *chloragogen* (Fig. 5) are very long, and build a dense coating to the intestine.

In the segments 4–8, the most part of the body-cavity is filled by *unicellular glands* (Fig. 11 *gl*); their very thin excretory prolongations form numerous threads directed towards the ventral side, which can be easily followed on the sections to the sides of the ganglion chain. Their thinness and flexuous course make it extremely difficult to follow them to their end on the surface of the skin. I believe that they converge towards the bundles of chaetae of the ventral series. As Mr. Michaëlsen writes me, these glands may be regarded as morphological equivalents to those gland-cells which in other Enchytraeids are related to the chaetae of the genital segments. In *Melanenchytraeus*, I don't think that these glands have any relation to the functions of reproduction, because I find them no less developed in immature specimens.

In some anterior segments, and peculiarly in the 9th and 10th, there are, between the nephridium and the body-wall, clusters of cells (Fig. 12 *x*) whose plasma is filled with very minute and strong refracting granules, rendering them obscure in transmitted light, white in incident light. These cells are not clearly outlined, and in the middle of each a small round nucleus appears. As a whole, these clusters have the aspect of glands, but no excretory duct could be detected. The aspect of the white and strong refracting granules leads me to think that they are uric products, and that the function of these problematic organs is excretory.

The *dorsal vessel*, or heart, appears on the sections from the 12th segment towards the head. Its posterior end is therefore neither praeclitellic nor postclitellic, but intraclitellic. This includes a *cardiac body*, or cardiac gland, of irregular shape, made of a small number of cells, in each transverse section. Having at my disposal only preserved specimens, I could not observe the colour of the blood ; I was unsuccessful in reconstructing from the sections the distribution and course of the blood-vessels.

The *lymph cells* seem to be all of one sort ; I have drawn some in Fig. 14.

The *nephridia* (Fig. 15) are of irregular shape, with few large nuclei ; the cells corresponding to these nuclei are not clearly outlined. Nearly the whole mass of the nephridium is built by the intricate and densely coiled tube. The wall of the excretory duct is thick and pigmented as it approaches the external opening. The latter lies on the line of the ventral bundles of chaetae, in front of the bundle of the segment in which it opens.

The *testicles* and *ovaries* offer no noteworthy peculiarities ; in my specimens the latter were little developed, even in the most mature, in which the spermatogenesis was rather advanced. This fact indicates a condition of proterandry.

In the more developed specimens enormous *sperm-sacs* extend from the 10th to the 15th segment, and fill nearly the whole body-cavity. We find in them all the stages of spermatogenesis—large spermatogonia, sphæric follicles derived from multiplication of them, and bundles of very minute zoosperms ; the latter are, however, in small numbers. But in most of the specimens I did not observe sperm-sacs nor spermathecae ; testicles and ovaries were very small and the sperm-ducts wanting, their distal part only being recognisable as a rudiment.

My Fig. 16 gives the reconstruction of the left *sperm-duct* from a series of sagittal sections. The funnel (*i n*) opens in the cavity of the 11th segment. It gives rise to a somewhat twisting tube, which runs backwards as far as the 15th segment, where it is tightly coiled ; from there it returns forward to its external opening in the 12th segment. The last tract forms a spherical bulb (*a*), but before reaching it the tube presents a fusiform swelling (*c*), whose wall is very thick and made of long cells, directed radially on the transverse section, the lumen being not widened. Bundles of prostatic (spermiducal) glands (*b*) are related to the bulb; another little group of glands (*c*) lies around the tube, above its fusiform thickening. As I mentioned above, the 12th segment, in which the sperm-duct opens, is deficient in ventral bundles of chaetae.

I have given in Fig. 17 a reconstruction of the *spermathecae*, made from a series of transverse sections of the most developed specimen, which I examined anatomically. Their external opening lies near the anterior limit of the 5th segment. A cylindrical duct made of cylindrical cells leads from the external opening to a wide cavity, which extends at its base into closed appendages or diverticula. These are only two larger on the right side, three smaller on the left. The two spermathecae communicate with one another, or, more exactly, they form a continuous whole, which traverses the dorsal portion of the intestine, without opening into the latter.

This anatomical description and the accompanying plate show so many singular facts in the structure of the worm examined, that I feel justified in forming for it a new genus, of which it is the only known species. From its obscure colour and light-shunning habits, I have called it *Melanenchytraeus solifugus*.

I translate here the diagnosis which I have already published in the *Rendiconti della R. Accademia dei Lincei*.[1]

Melanenchytraeus, Emery.

Hypoderm pigmented. All the segments with dorsal and ventral bundles of 4 chaetae each. The latter are slightly sigmoid, longer in the foremost segments. No ventral bundle in the 12th segment, which bears the opening of the sperm-duct. The latter is very long, and forms a coiled loop, extending back to the 15th segment. Above the spherical bulb, which forms its distal end, it presents a fusiform swelling; spermiducal glands are present. The sperm-sacs are ample, extending through several segments. The spermothecae do not open into the intestine; they are continuous with one another, and bear at the base of their ampullæ two or three diverticles each. The nephridia are very much convoluted, with few nuclei. The dorsal vessel begins in the 12th segment, and includes a cardiac gland. A cephalic pore is present, but no dorsal pores. The epithelium of the pharynx contains branched pigmented cells. There are no salivary glands, and no distinct limit separates the œsophagus from the intestine. In segments 4–8 the body cavity is largely taken up by unicellular glands, which, by means of long and very thin prolongations, reach the surface of the skin near the ventral bundles of chaetae.

[1] Vol. VII., 1° sem., ser. 5. *Seduta del* 6 *marzo*, 1898, p. 110.

M. solifugus, Emery.

The largest specimens are a little over one centimetre in length; the diameter of specimens preserved in spirits and moistened in water is about one-third of a millimetre. The body is cylindrical, tapering imperceptibly towards the hindmost extremity. The cephalic lobe is rounded. I counted 53 segments in one specimen. Colour dark brown, nearly black.

The sigmoid chaetae, the cardiac body, and the much convoluted nephridia assign to *Melanenchytraeus* a position near *Mesenchytraeus*. It differs from the latter chiefly by the long and complicated sperm-duct. The dark colouring of the hypoderm and other organs has not been observed in any other member of the Enchytraeidæ.

Explanation of the Plate.

Letters common to all figures.

cd dorsal chaetae.
cv ventral chaetae.
ce brain.
cu cuticle.
h hypoderm.
i intestine.
in funnel.
lc cephalic lobe.
ml longitudinal muscles.
mt transversal muscles.
ne nephridium.
nv ventral ganglion chain.
o mouth.
ph pharynx.
pn nephridial pore.
se septum.

Roman numerals indicate the order of the segments.

Fig. 1.—*Melanenchytraeus solifugus*; magnified 9 : 1.

Fig. 2.—Brain and œsophageal ring; reconstructed from a series of horizontal sections. In front of the brain the cephalic lobe shows a thickened hypoderm, with pigmented sense cells. 130 : 1.

Fig. 3.—Sagittal section of the foremost part of the body (combined from a series of not perfectly sagittal sections), *pc* cephalic pore, *v* blood-vessel. 130 : 1.

Fig. 4.—System of muscular bundles, which move the pharynx (*m*, *ph*); reconstruction; the outer wall of the body is supposed to be transparent. Of internal organs, the central nerve system and the intestines only are drawn. 100 : 1.

Fig. 5.—Section of the intestinal wall in the fore part of the body, with the chloragogene cells, *chl*; *ci* ciliated intestinal epithelium, *s* blood lacunes. 380 : 1.

Fig. 6.—Section of the epithelium of the pharynx; between the epithelial cells there are branched pigment cells. 380 : 1.

Fig. 7.—Transverse section of the body wall. 380 : 1.

Fig. 8.—Section of the body wall in the clitellar segment; from a specimen approaching maturity. 360 : 1.

FIG. 9.—Horizontal section of the cephalic lobe: *cs* sense cells. 380 : 1.

FIG. 10.—The four chaetae of a bundle in a posterior segment, isolated by means of caustic potash. 380 : 1.

FIG. 11.—Longitudinal vertical section of the 6th segment, showing the body cavity filled by unicellular glands *gl*. 250 : 1.

FIG. 12.—Longitudinal vertical section of the 10th segment, showing the cluster of granulated cells, *x*, and the large dark pigmented cells, *pg*, which lie around the bundles of chaetae. 250 : 1.

FIG. 13.—Longitudinal section through the ventral bundle of chaetae in a posterior segment. 250 : 1.

FIG. 14.—Three lymph cells in the coëlome. 380 : 1.

FIG. 15.—The right nephridium of the 15th segment, with the neighbouring bundles of chaetae. Combined figure from two sections. 250 : 1.

FIG. 16.—Reconstructed sperm-duct of the right side. *p* pore, *a* bulb (drawn as semi-transparent), in which the prostatic glands *bb* open; *c* fusiform swelling of the duct; *d* loop surrounded by the glands *e*; *in* funnel. 130 : 1.

FIG. 17.—Reconstructed spermathecae as a transverse section (from a series of transverse sections), *prs* external pore, *drs* duct, *rs* cavity of the spermathecae, *ars* its appendages. 130 : 1.

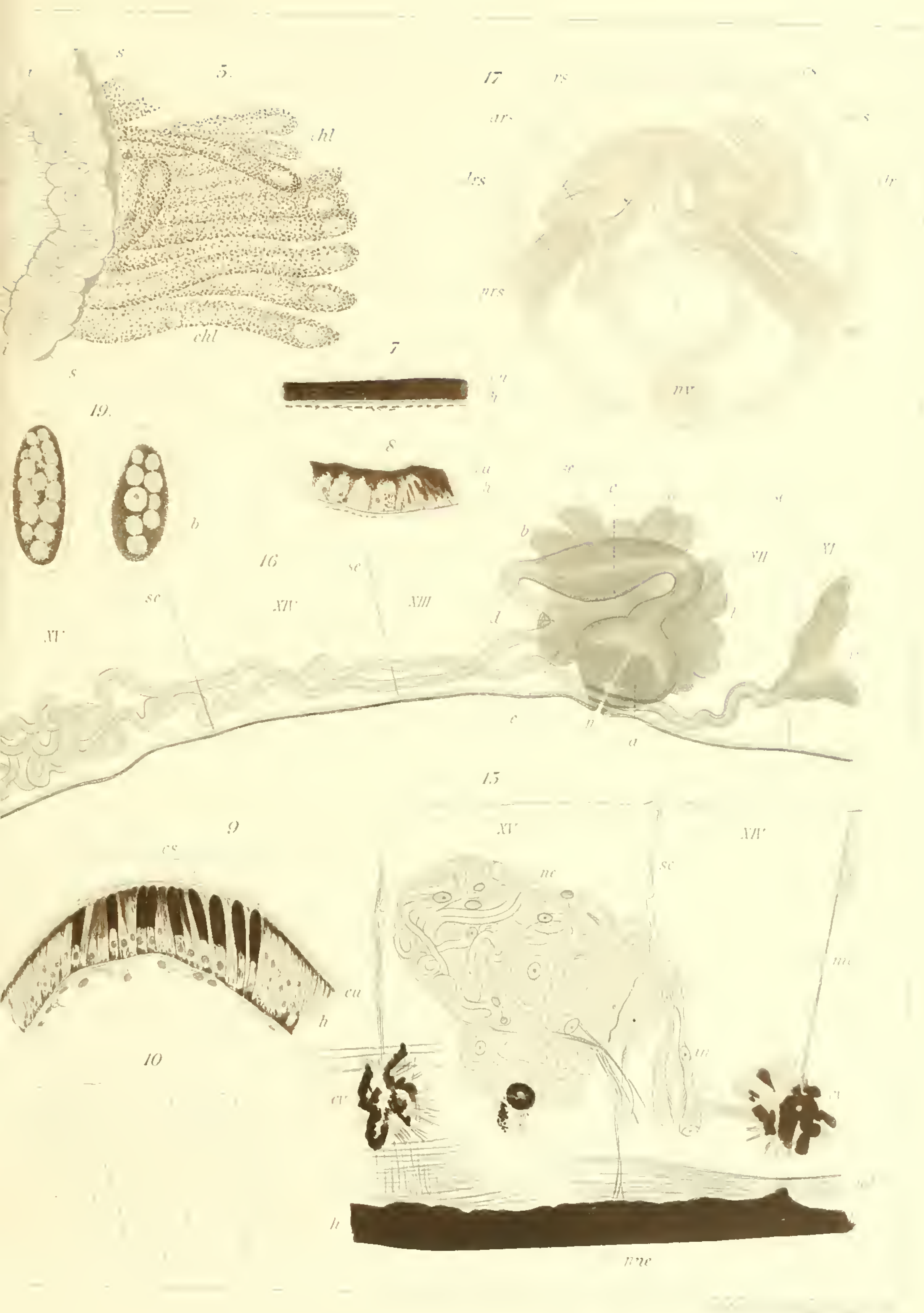
FIG. 18.—*Anoplophrya* sp? parasite in the intestine of *Melanenchytraeus*. 380 : 1.

FIG. 19.—Parasitic cysts from the intestine of *Melanenchytraeus*; *a* entire cyst; *b* longitudinally cut cyst, showing its contents of nucleate clear globules separated from each other by pigmented matter. 380 : 1.

Additional Note.—The Italian edition of the above pages was in the press when I received from Mr. Percy Moore a separate copy of his valuable paper on the Alaskan Enchytraeid.[1] Mr. Moore had at his disposal many more specimens than I had, and among them a number of sexually mature specimens, which allowed him to recognise the ovisacs and female pores. He found that the spermathecae do communicate with the intestine by a small pore. I have revised the only series of sections which I possess from a specimen with apparently fully developed spermathecae, and cannot find any pore; but the organs lie in close contact with the intestinal wall, and it may be supposed that my specimen was abnormal or not fully mature.

[1] *A Snow-inhabiting Enchytraeid* (*Mesenchytraeus solifugus*, Emery), collected by Mr. Henry G. Bryant on the Malaspina Glacier, Alaska, in *Proc. Acad. Nat. Sc. Philadelphia*, 1899, pp. 125–144, pl. VII.

MELANENCHYTE



S SOLIFUGUS.

MELANENCHYTRAEUS SOLIFUGUS.

Mr. Moore describes another smaller species whose spermathecae are without diverticula, and calls it *M. nivus.* This and *M. solifugus* he refers to the genus *Mesenchytraeus*, regarding the characters of *Melanenchytraeus* not sufficient to justify a separate genus.

After the snow was melted on the glacier, Mr. Bryant observed the worms to become more active, living in little water pools on the glacier. I suppose that the most mature specimens came from such localities, and that the eggs are laid in the water. Mr. Moore examined also specimens collected by Mr. Wright on the Muir Glacier, and identified them with both *M. solifugus* and *nivus.*

BOLOGNA *July*, 1899.

APPENDIX E

Rocks and Minerals of South Alaska

ALTHOUGH limited to a small number of specimens, the collection of rocks and minerals gathered on Mount St. Elias by the Italian expedition is one of considerable interest as coming from a region that is so remote and difficult of exploration.

Our knowledge of the geology of South Alaska is exclusively based on two reports by I. C. Russell, recounting his expeditions to St. Elias in 1890 and 1891. As frequent reference will have to be made to these reports, we shall designate them, for the sake of brevity, as Nos. I. and II.[1]

It is necessary to study these reports in order to appreciate the nature and value of the collection; while the latter, in its turn, serves to throw a little light on some of the many obscure and doubtful points in our geological knowledge of this distant and interesting land.

According to Mr. Russell (*vide* I., p. 167), the different components of the soil of South Alaska are all stratified, and may be grouped in three formations or systems, denominated by him as follows, and disposed, in order of date, from the most recent to the oldest period:—

I. The Yakutat System.
II. The Pinnacle System.
III. The St. Elias Schists.

But of only one of these systems has the precise age been ascertained. As all the marine fossils found by Russell in the Pinnacle formation belonged to species still surviving on the Alaskan coasts, the soil containing them is evidently of recent origin, probably belonging to the *Pleistocene*, and certainly not anterior to the *Pliocene* formation. While exploring the Chaix Hills, during his second expedition (II., p. 24), Russell ascertained the strata of the Pinnacle System to be of glacial origin and identical with those deposited at the base of the present Malaspina Glacier, at every point where it comes down to the sea, as at Icy Cape or the Sitkagi Bluffs (II., p. 56). Therefore,

[1] ISRAEL COOK RUSSELL. "An Expedition to Mount Elias, Alaska," *The National Geographic Magazine*, Vol. III., pp. 53–200, plates 2–20 (I.); Washington, 1891. *Id.*, "Second Expedition to Mount St. Elias," *Thirteenth Annual Report of the U. S. Geological Survey*, 1891–92; Part II., "Geology," pp. 7–91, plates 3–21 (II.); Washington, 1893.

as regards their origin and their fossils, these strata are identical with those of the present day, and only distinguished from the latter by their great elevation (5,000 feet) above the sea-level. This is one of the most interesting results of Russell's explorations, inasmuch as it positively proves the existence of an upheaval at above 5,000 feet, during a very recent geological period that can only be compared with that of the *quaternary* terraces at Aspromonte in Calabria, although the latter do not reach to more than 3,750 feet at the highest. Besides, the enormous thickness of the *moraine*-formation, which, according to Russell, cannot be estimated at less than 4,000 to 5,000 feet, proves that the upheaval must have been preceded by a prolonged glacial period, during which the climatic conditions of the country must have been analogous with those found there at the present day. But we have yet to ascertain whether in the interval between that not very remote geological period and the present time the glaciers passed through the same phases of advance and shrinkage which, having been verified in the rest of North America and in Europe, justify our division of the glacial epoch into various ages separated by interglacial periods, during which the glaciers were of smaller extent or disappeared altogether. This mighty glacial formation built up the Pinnacle Cliffs, Samovar Hills, Moore's Nunatak, and the Robinson Hills.

Russell maintains that the *Yakutat System* is much more recent than the Pinnacle System, the former being a very thick sandstone and schistous formation, in which considerable displacements and contortions are noted and entirely dissimilar from that of the *Pinnacle System*, wherein, as a rule, the strata are almost horizontal, or very slightly bent. If Mr. Russell's opinion as to the relative age of these Yakutat strata were to be accepted, it would imply that there must have been sufficient time during one of the above-mentioned interglacial periods occurring between the very recent period giving birth to the *Pinnacle System* and the present condition of the earth for the deposit of masses of sandy and schistous strata of a thickness that even Russell shrinks from estimating, and that is undoubtedly very great.

This is not the only hazardous assertion Russell has advanced. The Hitchcock Range and the crags to the north of Pinnacle Pass are all composed of Yakutat strata, which are also found on Mount Owen, at Dome Pass, and from the great rock-spurs at the base of Mounts Augusta, Malaspina, and St. Elias. In these three latter localities the Yakutat strata dip beneath the schists forming the crest of the St. Elias range and constituting exactly the third of Russell's geological systems. But as he finds it impossible to admit that this superposition could have existed from the first—an hypothesis that would have compelled him to consider the St. Elias schists to be even more recent than the Yakutat strata—Mr. Russell was obliged to adopt the theory that through some fault parallel with the line of the strata, the schists had been upheaved and thrust up on top of the sandstones (*Vide* I., p. 168 and p. 174).

Nevertheless, Mr. Russell was well aware of the improbability of all such superpositions and settlings, and in his first pamphlet, written before discovering the glacial origin of the Pinnacle System, he confesses, with a frankness that does him honour, that "the relative ages of the Yakutat and Pinnacle series is the weakest point in the geological history he had sketched" (I., p. 173). During his second expedition, he found no opportunity of resuming the subject, and thus the solution of the question is left to the future.

Russell likewise gives a scheme of the geological structure of the region. This, however, is based on the supposed existence of a fault that has thrust the St. Elias schists over the Yakutat sandstones, a fault, moreover, running absolutely parallel with the stratification which bends towards north-east at an angle of 15°. The disorder and contortion visible in the Yakutat series would have been consequently caused by the overthrust of the said fault. So the whole of the actual appearance of the region surrounding St. Elias would be due to a system of enormous faults of later date than the first, which, in crossing one another, would have split the surface of the soil into independent fragments or blocks, and which, by the action of the various pressures (or thrusts), would have all dipped to the north.

The south face of Mount St. Elias, formed of the heads of the strata, would be the fault-scarp of one of those blocks; the easier slope of the mountain, on the northerly side, would consist of the surface of the strata. In fact, both Russell's photographs and those taken by the Italian expedition show a very distinct line of stratification dipping north or north-east. But now that the terminal pyramid is known to be composed of diorite, it is also possible that the so-called stratification are simply planes of division or cleavage in the solid rock.

Russell attributes to all these dislocations the present altitude of the *Pinnacle System* strata above the level of the sea. In that case, the upheaval of the whole mountain system of South Alaska would be posterior to the Yakutat strata, consequently no older than the Pleistocene, and, at all events, of a very recent period.

This, though one cannot deny it *à priori*, certainly constitutes a very novel and singular fact; but the value of it is greatly lessened when we remember that all this hypothetical edifice is built up from a foundation the solidity of which is questioned by its author.

Until fresh observations shall have absolutely proved it to be true that the Yakutat sandstones are really of later origin than the *Pinnacle System*, Mr. Russell's theories regarding the origin of Mount St. Elias must be received with the utmost caution.

A. *The Terminal Pyramid of St. Elias.*

As regards the nature of the rock constituting the terminal pyramid of Mount St. Elias, Mr. Russell gives only one incidental hint (II., p. 49), when he mentions having met with an outcrop of dark diorite about *3,150* feet above the Russell Col. In the geological notes to his first expedition, he gives even vaguer hints, since in these he merely says that the rocks forming the Mount St. Elias range are metamorphic schist, and that he purposely abstains from going into particulars from lack of conclusive observations (l. p. 173).

Accordingly, the two authentic specimens of the peak brought home by the Italian expedition form a precious contribution to our knowledge of its lithology. These fragments prove the truth of Russell's hasty examination: the St. Elias rock is really of the typical *diorite*, which in places merges into *amphibolite*.

1. Diorite of typical appearance with small and middle-sized grains: nevertheless, in this single, rather small specimen, the granulation is perceptibly varied. Its structure is granulated hypidiomorphic, without any trace of porphyritic structure. No one of the essential elements has a decidedly crystallographic outer edge; only the hornblende shows facets of the prism here and there. Its chief mineral components are hornblende and labradorite, with a mixture of a *pyroxene* showing scarcely any colour in thin section.

Titanite (Sphene), in very minute crystals of rounded outline, is the most abundant of the accessory components; there is very little *pyrite* and *magnetite*; *calcite* and *epidote* are included among the secondary minerals.

The *plagioclase* looks white and still semi-transparent in the rock itself; in thin sections it remains sufficiently clear and almost unchanged, a fact which renders the comparative abundance of calcite somewhat puzzling. It shows the usual multiple twinning of albite and pericline. Its optical characters correspond with those of a rather more basic labradorite than the *Ab* 1, *An* 1, perhaps therefore an *Ab* 5, *An* 6.

The amphibole has the usual appearance of the deep green hornblende of typical diorites.

Dr. Ettore Mattirolo has carefully analysed the St. Elias diorite at the Chemical Laboratory of the R. Ufficio Geologico, and has also ascertained its specific gravity. According to his report, the rock under the blowpipe melts somewhat easily into a black, rather porous and magnetic glass, the action of acids on it producing a slight effervescence. The stone, when reduced to powder, has a greenish grey tint; when moistened with water, it shows perhaps a more marked alkaline reaction than is generally seen in similar rocks; when heated in a closed tube and heated to 110°, it gives out a little combined water, the analysis of which, however, was not carried further. The quantitative analysis was performed on the substance dried at 110° C. The composition is detailed in the following table. It should be noted that the determination of the relative proportions of iron in the form of ferrous and ferric oxide was not carried out, but apparently the former (ferrous oxide) predominates over the other.

SiO_2	46·65
TiO_2	1·03
CO_2	0·57
Ph_2O_5	traces
Al_2O_3	16·29
FeO	10·54
MrO	traces
CaO	13·22
MgO	8·13
Na_2O	2·78
K_2O	traces
S (of pyrites)	traces
Loss by fusion (CO_2 deducted)	1·56
	100·77

Six determinations of the specific gravity of the rock, made on different specimens at an ordinary temperature, gave values varying between 3·00 and 3·06, with a medium value of 3·018.

From the general result of Mattirolo's analysis, the Mount St. Elias diorite seems to approach those types in which an increase of basicity is caused by the predominance of hornblende over feldspar. Where this predominance becomes more marked, one arrives at the following type (No. 2).

2. Amphibolite.

This consists of the diorite hornblende slightly interspersed with an occasional granule of labradorite. This must be certainly a variety of the preceding rock in which hornblende predominates, in greater crystals with very clear and glittering cleavage facets.

According to De Filippi's statement, the last spurs of rock encountered in the ascent of the Mount St. Elias peak at 16,500 feet are formed of this variety.

B. *Base of Buttress East of St. Elias, in the direction of Agassiz Glacier. Vertical Strata. In the "Couloir" running up to the Newton.*

Close-grained psammitic, quartzite sandstone, of very regular structure. Of a greyish colour, which is chiefly due to very small specks of black mica. Slight variations of tint are evidences of very narrow and regular stratification. The facets of the specimen become covered with a reddish-brown limonitic crust after exposure to the air.

C. *North-east Cupola of the Dome Pass.*

Sandstone of irregular, medium-sized grains, these grains being slightly imbedded in a siliceous-argillaceous cement, the friability of the stone being probably due to the action of the air and fresh rock more solid. A thin section of the rock shows an aggregate of sharp-edged grains of quartz; fragments of feldspar more or less changed, a few of them still showing the streakings characteristic of labradorite ; and lastly, of sufficiently fresh spangles of biotite ; almost all, however, with flexures, cracks and foldings, showing that the whole mass had been subjected to pressure.

D. *North Bastion of the Hitchcock Range, Western Face.*

Fine-grained psammitic sandstone, of a yellowish-grey tint. On the lamination-planes, parallel with the stratification, there are very minute glittering particles of mica.

The three sandstone specimens, *B*, *C*, and *D*, do not seem to be different rocks, but, on the contrary, varieties of the same type of psammitic sandstone with a silico-argillaceous cement and no trace of calcareous elements. Probably all three specimens belong to the Yakutat formation, which is, in fact, composed of sandstone and black schist, showing violent flexures, dislocations, and disturbances.

E. *Base of the North Bastion of the Pinnacle Glacier (Pinnacle Cliffs). Russell Camp.*

All the specimens are of the *Pinnacle formation* which at Pinnacle Cliffs has a thickness of about 1,900 feet, and consists of alternating layers of sandstone and various conglomerates, clays, and schists. Strange to say, its upper portions also comprise a bed of limestone with fragments of *Pecten*. The chief mass of the formation consists of a sandy clay with pebbles, in which the erosion caused by rain leads to the formation of pinnacles and spires, a characteristic fact which is also evidenced in the "earth pyramids" found in the morainic formations of many Alpine districts. This sandy and clayey formation, with flattened, streaked and smooth pebbles, is really—as Mr. Russell acknowledged on his second expedition—a moraine once deposited in the sea, and therefore still containing a few fossil shells.

The material collected by the Italian expedition accordingly contains a certain number of erratic pebbles, and some fragments of scarcely recognisable fossils embedded in their rocky matrix.

1. A quartzite pebble seamed with lines of fracture, with displaced fragments recemented along the lines. It is a splendid specimen of the stones to which Mr. Russell applies the name of *faulted pebbles* (l., p. 171, and figures 7 and 8).
2. A quartzite pebble with cracks, but with no displaced fragments. Of slightly trigonal shape.
3. A small pebble of whitish granite or arkose with black mica.
4. Sandstone similar to D.
5. Conglomerate of small pebbles with a calcareous cement.
6. Soft sandstone with a calcareous cement, and fossil fragments of an unrecognised bivalve.

7. Blackish shale containing fossils. The said fossils are fragments of shells, and forms belonging certainly for the most part to the genus *Cardium*.

As a supplement to the preceding notes, I subjoin Mr. Russell's list of the fossil *species* he found on his two expeditions. During the first the following *species* were collected on Pinnacle Cliffs (I., p. 172) :—

Mya arenaria, L.
Mytilus edulis, L.
Leda fossa, Baird—L. *minuta*, Fabr.
Macoma inconspicua, B. & S.
Cardium islandicum, L.
Litorina atkana, Dall.

Besides these, Russell notes (II., pp. 170, 171) the presence of large *Pecten* shells (*P. caurinus* (?) Gld.) in the calcareous layer covering his Pinnacle series.

The species found on the Chaix Hills are the following (p. 25) :—

Cardium islandicum, L.
Macoma sabulosa, Spengler.
Natica, op. ?
Nucula (2 undetermined species)
Panopea arctica, Lam.
Thracia curta, Cour.
Yoldia limatula, Say.
Yoldia (cfr. *myalis*).
Yoldia (cfr. *obesa*).
Yoldia thraciaeformis, Shorer.

Lastly, in a subglacial clay of a very recent period, near the front of the Malaspina Glacier, and at a little height above the sea, Mr. Russell found some other fossil shells, which, according to Dall's identification (II., 63), would include the following species :—

Cardium gronlandicum, Gronl.
Cardium islandicum, L.
Kennerlia grandis, Dall.
Leda fossa, Baird.
Macoma sabulosa, Spengler.

F. *Base of the Frontal Moraine of the Malaspina Glacier, North of Manby Point ;* 42 *miles to S.S.E. of Mount St. Elias.*

Manby Point is situated in about the exact centre of the frontal arch of the Malaspina Moraine, but in such a position as to lead one to infer that the majority of substances found there had been brought down by the Seward Glacier. Nevertheless, it is impossible to decide as to the real source of the substances, inasmuch as the Seward, where it debouches into the Malaspina, is flanked by the Samovar Hill, and by the cliffs of the Pinnacle Pass, which being formed of a moraine-deposit of relatively great antiquity and unknown origin, may be the source of much of the erratic material predominating on Manby Point.

Having made this reserve, we may enumerate the different species of rocks and minerals collected there :—

1. Diorite.

2. Amphibolite.

These two rocks are almost identical with those of the terminal pyramid of St. Elias. But as the St. Elias pyramid stands outside the basin which is a tributary of the Seward, the evidence of those rocks is in favour of the existence of dioritic rocks in the mountains to the east of Mount St. Elias, unless it can be shown that they are derived from the conglomerates of the Samovar Hills.

3. Felspathic rock with a chloritized mineral, possibly a partially changed diorite or gabbro. Mr. Russell maintains (I., p. 168) that the central (or medium) moraines of the Haydn and Marvine Glaciers—both tributaries of the Malaspina—are formed of gabbro and serpentine, a fact that would apparently indicate the presence of identical rocks on the southern slope of Mount Cook.

4. Amphibolic granite. Rocks with altered feldspar, chloritized black mica, and brownish-green hornblende, with a certain amount of quartz.

5. Actinolite schist.

6. Dioritic gneissiform schist.

7. Actinolite in long prisms contained in a mass of citrine quartz.

8. Aplite.

9. Light green actinolitic schist.

10. Black jasper in pebbles.

11. Slaty-black schist.

12. Pegmatite.

13. Vein-quartz.

14. Micaceous black rock with the formation and appearance of a grauwacké metamorphozed by contact, with a prism of *andalusite* of several centimetres in length, with rhomboidal sections from less than one centimetre in length to about one centimetre. Although this mineral seems to be interpenetrated by the schistous cement of the rock, it affords some very fresh, clear fragments, which are slightly coloured and pleochroic, very light green and pink.

INGRE VITTORIO NOVARESE.

ROME. ROYAL GEOLOGICAL OFFICE, *March*, 1899.

APPENDIX F

Works on Alaska in General

This list gives merely the titles of the books and articles consulted in order to amplify the description of the country traversed by the expedition, and to compile an historical account of earlier explorations. Although incomplete, the summary may serve as a guide to those who are desirous of obtaining fuller information regarding Alaska and the region of Mount St. Elias.

W. H. DALL. *Alaska and its Resources*, 1870.

— *Report on Mt. St. Elias, Mt. Fairweather, and some of the Adjacent Mountains.*—Report of the Superintendent of the U.S. Coast Survey for 1875.

C. E. S. WOOD. *Among the Thlinkits in Alaska.*—The Century Magazine, July, 1882.

I. PETROFF. *Population, Industries and Resources of Alaska.* 1884.

I. C. RUSSELL. *Glaciers of Alaska.*—Fifth Annual Report of the U.S. Geological Survey for 1883–84. Washington, 1895.

H. W. ELLIOT. *Our Arctic Province.* New York, 1887.

G. F. WRIGHT. *The Ice Age in North America.* London, 1890.

I. C. RUSSELL. *A Journey up the Yukon River.*—Bulletin of the American Geographical Society, Vol. XXVII., 1890, n. 2.

— *Notes on the Surface Geology of Alaska.* — Bulletin of the American Geological Society, Vol. I., 1890.

A. BADLAM. *The Wonders of Alaska.* S. Francisco, 1891.

H. P. CUSHING. *Notes on the Muir Glacial Region, Alaska and its Geology.*—American Geologist, Vol. VIII., 1891.

H. F. REID. *Studies on the Muir Glacier.*—National Geographic Magazine, Vol. IV., 1891.

F. SCHWATKA. *Wonderland, or Alaska and the Inland Passage.*—Alpine Journal, Vol. XII., 1891.

H. W. SETON-KARR. *Explorations in Alaska and North-West British Columbia.*—Proceedings of the Royal Geographical Society, Vol. XIII., 1891, n. 2.

I. C. RUSSELL. *Climatic Changes Indicated by the Glaciers of North America.*—The American Geologist, Vol. IX., 1892.

C. W. HAYES. *An Expedition to the Yukon District.*—National Geographic Magazine, Vol. IV., 1892.

I. C. RUSSELL. *Alaska: Its Physical Geography.*—The Scottish Geographical Magazine, Vol. X., 1894.

— *Glaciers of North America.*—Boston, 1897.

ALASKA.—Bureau of the American Republics. Handbook n. 84, August, 1897.

WORKS HAVING SPECIAL REFERENCE TO THE MOUNT ST. ELIAS REGION.

F. SCHWATKA. 1. Letter to the *New York Times*, October 17, 1886.

— 2. *The Expedition of the "New York Times"* (1886).—Century Magazine, April, 1891.

W. LIBBEY. *Some of the Geographical Features of South-Eastern Alaska.*—Bulletin of the American Geographical Society, Vol. XXIII., 1886.

H. W. SETON-KARR. 1. *Shores and Alps of Alaska.* London, 1887.

— 2. *The Alpine Regions of Alaska.*—Proceedings of the Royal Geographical Society, Vol. IX., 1887.

H. W. TOPHAM. *A Visit to the Glaciers of Alaska and Mt. St. Elias.*—Alpine Journal, Vol. X., 1889; and Proceedings of the Royal Geographical Society, Vol. XII., 1889.

W. WILLIAMS. *Climbing Mount St. Elias.*—Scribner's Magazine, April, 1889; and in Mountain Climbing.—"The Out-of-Door Library," Scribner, New York, 1897.

I. C. RUSSELL. 1. *An Expedition to Mount St. Elias, Alaska.*—The National Geographic Magazine, Vol. III., 1891.

I. C. RUSSELL. 2. *The Expedition of the National Geographical Society and the U.S. Geological Survey* (1890).—The Century Magazine, April, 1891.

M. B. KERR. *Mount St. Elias and its Glaciers.*—Scribner's Magazine, March, 1891; and in Mountain Climbing.—"The Out-of-Door Library," Scribner, New York, 1897.

J. STANLEY-BROWN. *Report on Auriferous Sands from Yakutat Bay.*—National Geographic Magazine, Vol. III., 1891.

F. H. KNOWLTON. *Report on Fossil Plants from Pinnacle Pass, near Mt. St. Elias, Alaska.*—National Geographic Magazine, Vol. III., 1891.

I. C. RUSSELL. 1. *Second Expedition to Mount St. Elias.* — Thirteenth Annual Report of the U.S. Geological Survey for 1891–92. Washington, 1894.

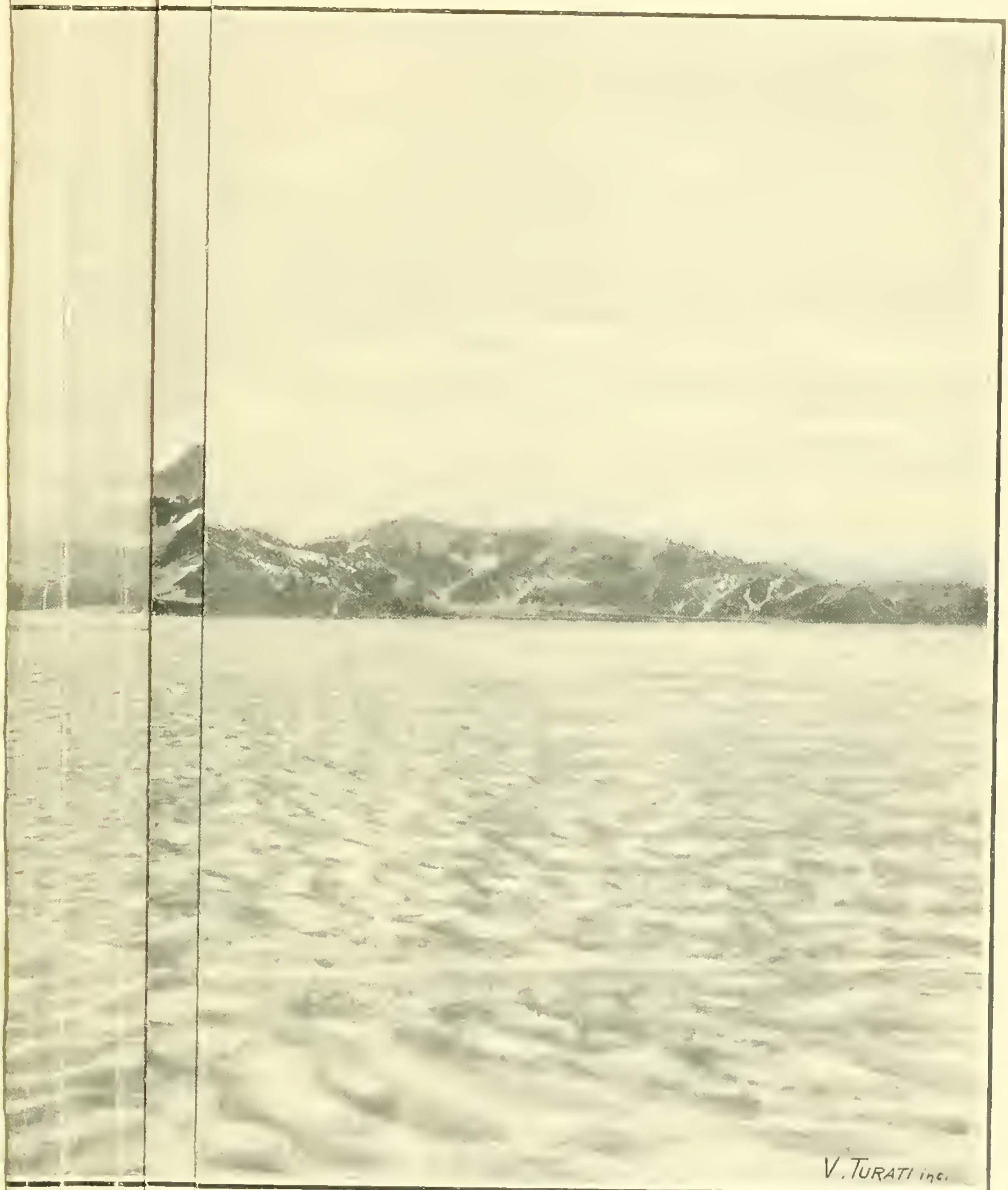
— 2. *Mount St. Elias Revisited.*—The Century Magazine, June, 1892.

— 3. *Malaspina Glacier.*—The Journal of Geology, Vol. I., 1893, n. 3.

— 4. *Mountaineering in Alaska.*—Bulletin of the American Geographical Society, Vol. XXVIII., 1896, n. 3.

Butler & Tanner, The Selwood Printing Works, Frome, and London.

Bering. N



es to

THE CHAINS OF M.T S. ELIAS AND M.T COOK FROM

E MALASPINA GLACIER (10 miles to the S. E. of the outflow of Seward glacier)

. Pinnacle glacier. 5. Hitchcock glacier.

THEA

STABILIMENTI V. TURATI — M. BASSANI — MILANO

THE CHAIN OF M.T S.T ELIAS AND AUGUSTA SEEN FROM THE EASTERN SIDE OF SEWARD GLACIER,

NEAR ITS OUTFLOW INTO MALASPINA GLACIER.

1. Seward glacier. 2. The Hitchcock chain. 3. Pinnacle-Pass. 4. Dome-Pass.
5. Agassiz glacier. 6. Savoy glacier.

AS, SEEN FROM RUSSELL COL.

Malaspina.

Bering. Vancouver. Augusta. Hubbard (in the distance). Cook.

Stabilimenti V. Turati - M. Bassani - Milano

Newton Valley.

1. Seward glacier. 2. The Hitchcock chain. 3. Pinnacle-Pass. 4. Dome-Pass.
5. Agassiz glacier. 6. Savoy glacier.

THE REGION TO THE EAST AND SOUTH-EAST OF M^t St. ELIAS, SEEN FROM RUSSELL COL.

Seward glacier.

E NORTH, FRO

Stabilimenti V. Turati e M. Bassani — Milano

THE COUNTRY TO THE NORTH, FROM THE NORTH-EASTERN RIDGE OF M.t St. ELIAS, AT AN ALTITUDE OF 16500 FEET.

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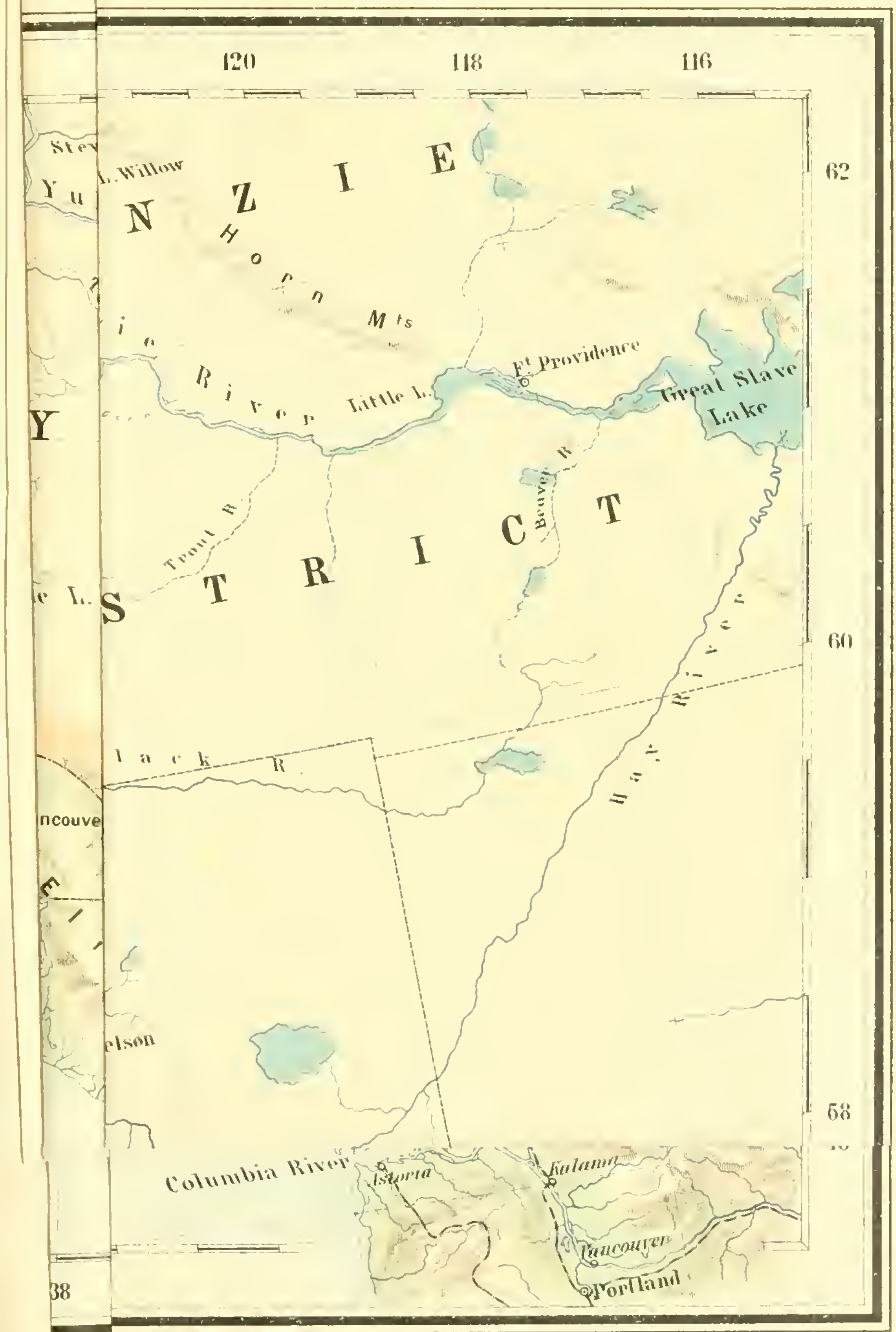

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